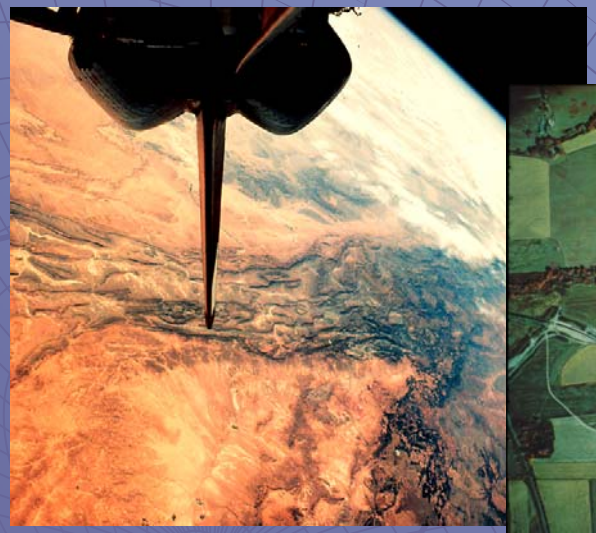
Elements of Interpretation



Training Center

U.S. Geological Survey
Center for Earth Resources
Observation and Science (EROS)
Sioux Falls, South Dakota, USA

Applications of Coarse to High Resolution Satellite Imagery for Land Productivity Assessment & Management

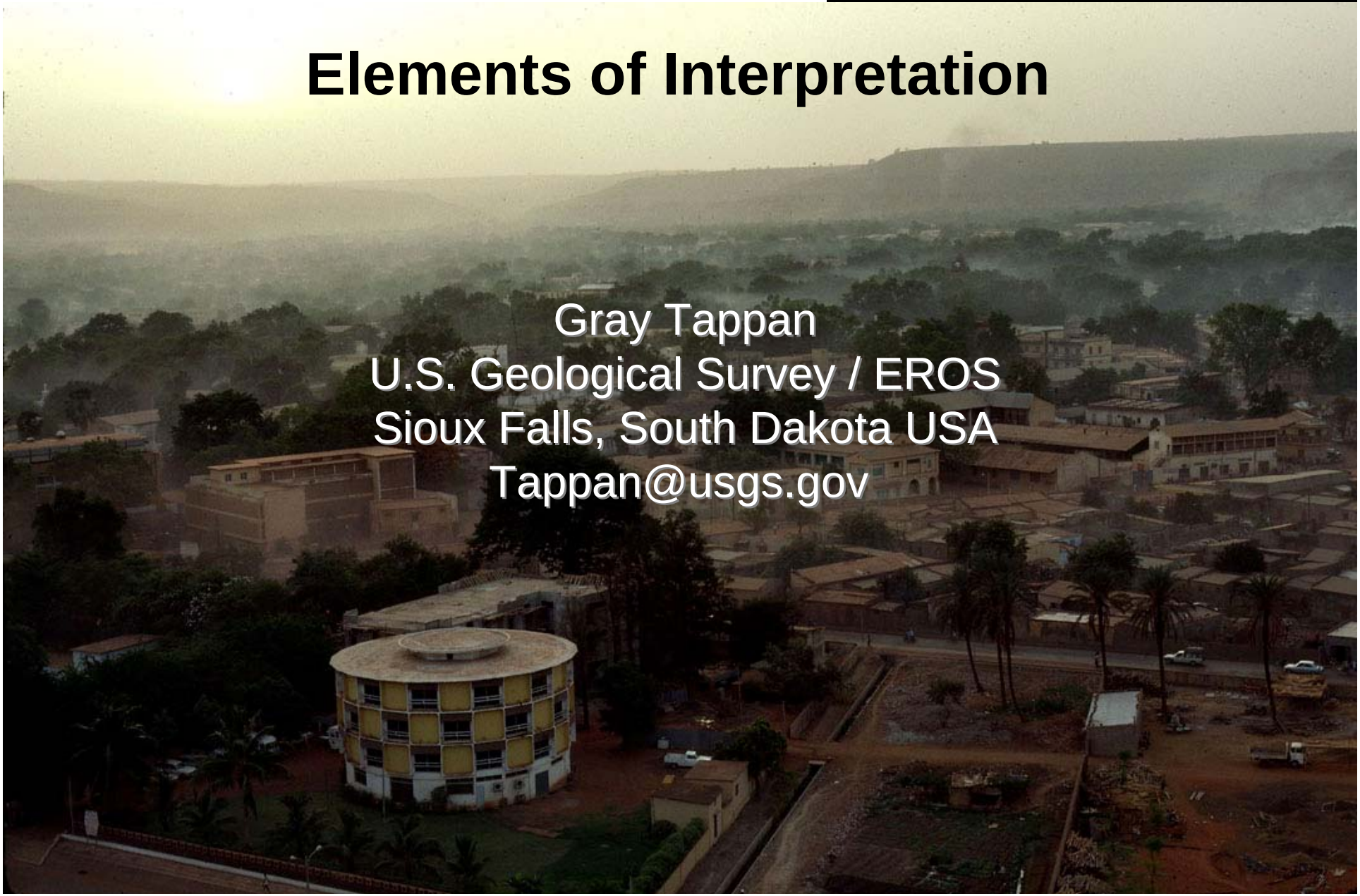
Elements of Interpretation

Gray Tappan – SAIC / USGS EROS

Bamako , Mali

6 - 17 February, 2006

USGS
science for a changing world



Elements of Interpretation

Gray Tappan
U.S. Geological Survey / EROS
Sioux Falls, South Dakota USA
Tappan@usgs.gov

Presentation Outline

- Remote sensing – a few remarks
- Spectral Reflectance – a quick review
- Film types and spectral bands
- Aerial photography
- Landsat spectral bands

Les avantages de la télédétection

- Vue globale
- Position stratégique unique
- Information extra visuelle
- Document permanent

La télédétection géographique

La télédétection géographique utilise des images pour comprendre les paysages en fonction du :

- Lieu
- Temps
- Echelle

Les besoins de la recherche géographique

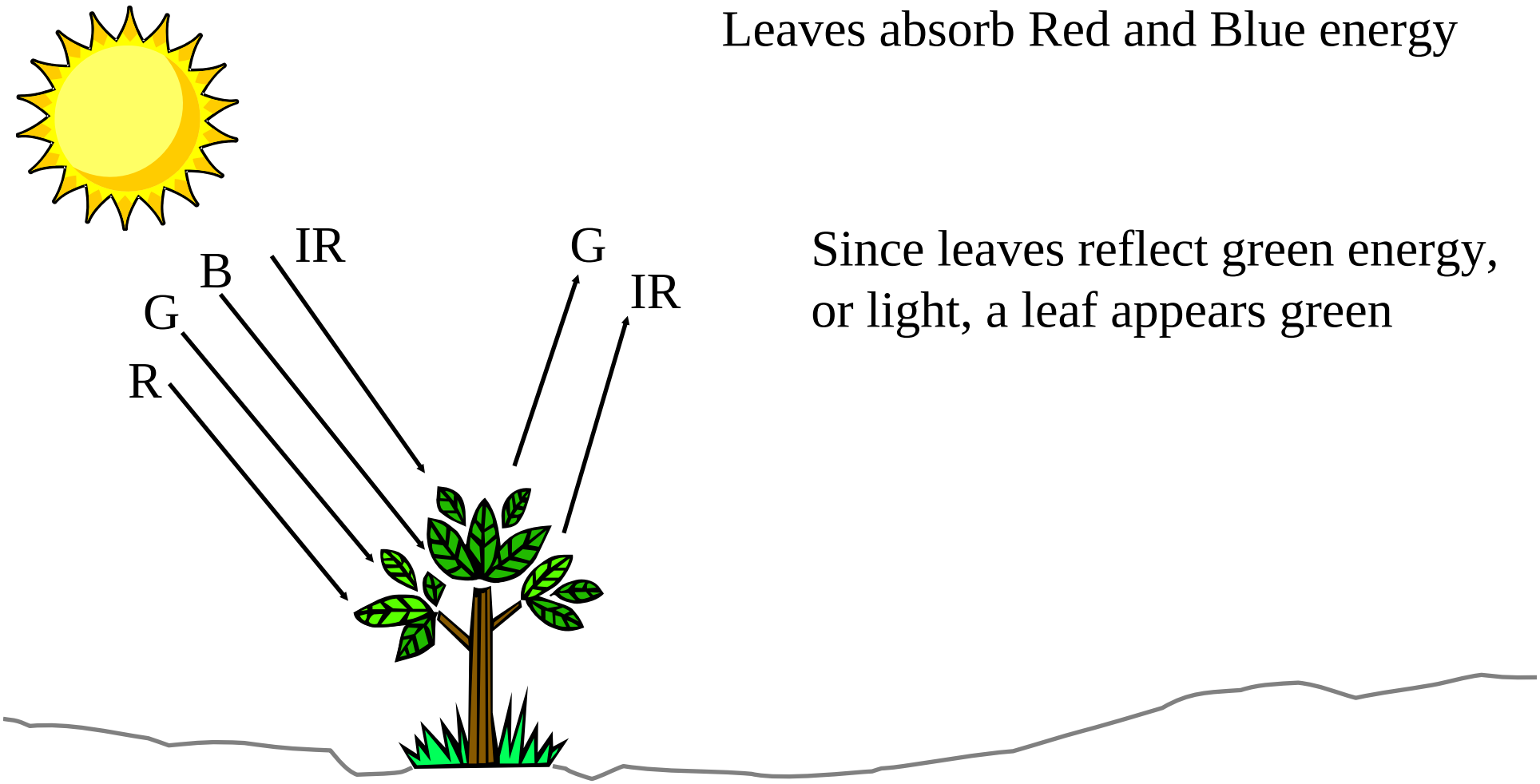
La recherche géographique nécessite en général une description ou une mesure pour déterminer les caractéristiques suivantes d'un phénomène :

– Propriétés physiques
– Propriétés spatiales (géographiques)
– Propriétés temporelles

La télédétection est clairement une source d'informations pour les trois types de propriétés.

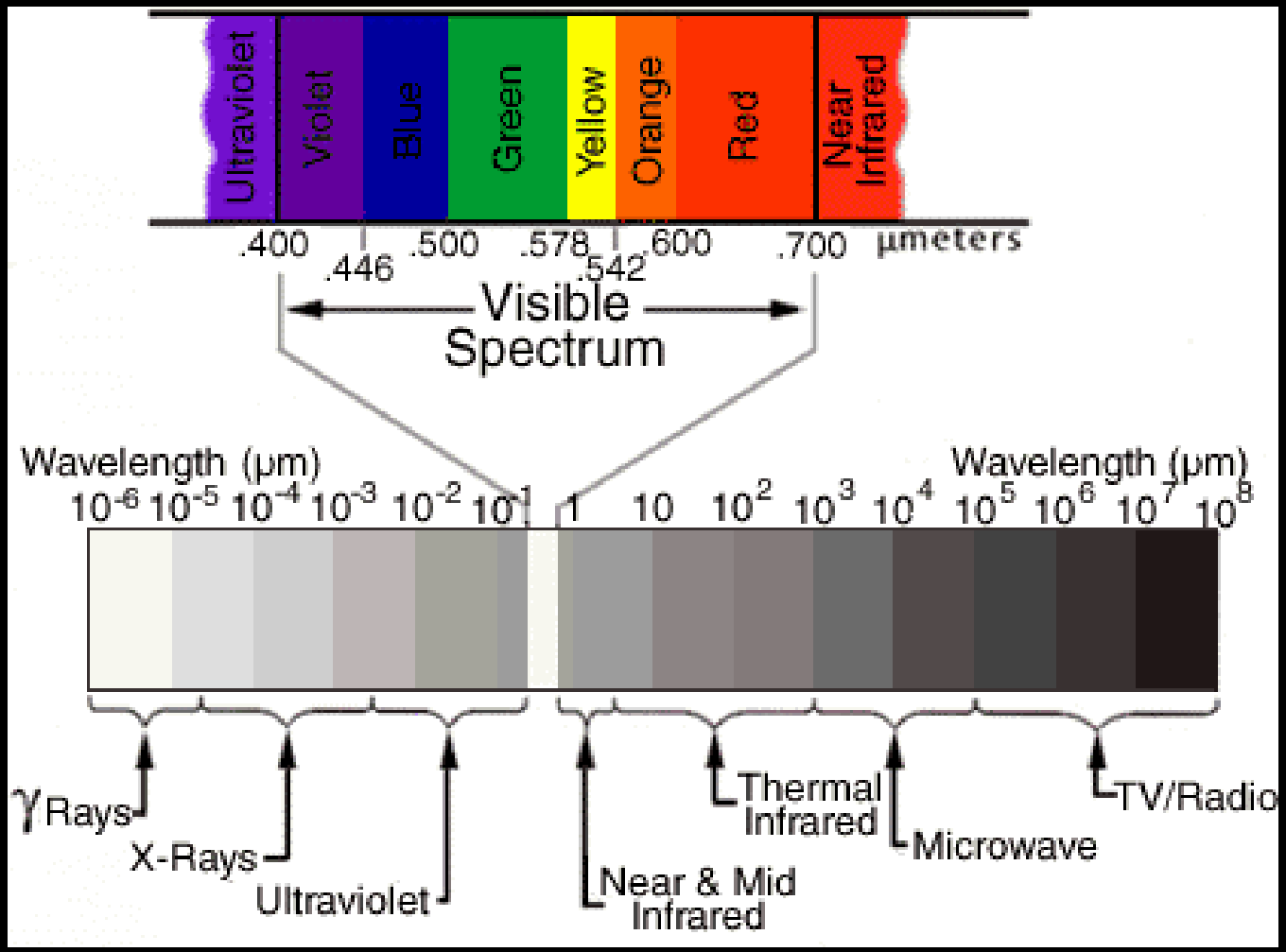
Why is a leaf green?

Leaves absorb Red and Blue energy

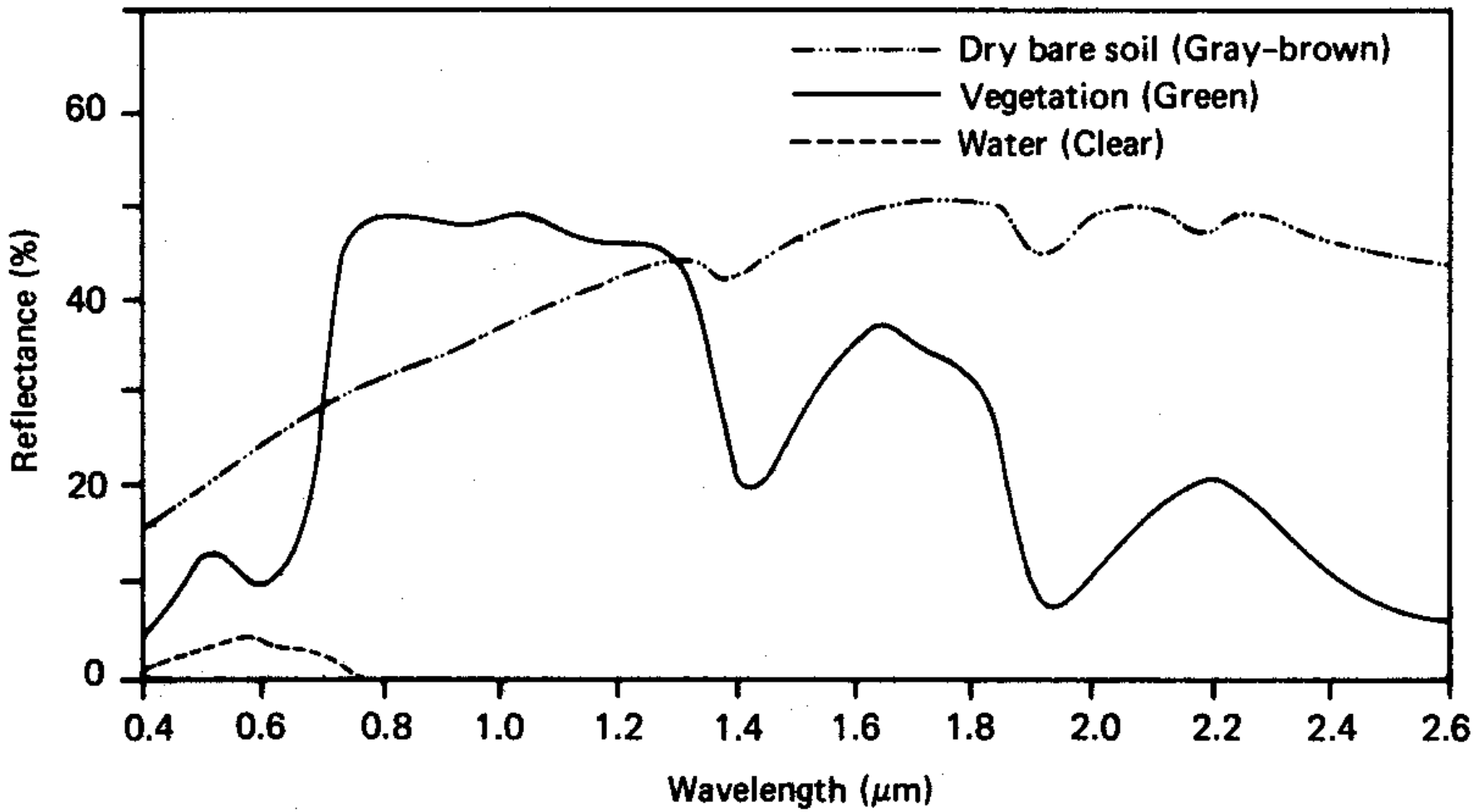


Since leaves reflect green energy, or light, a leaf appears green

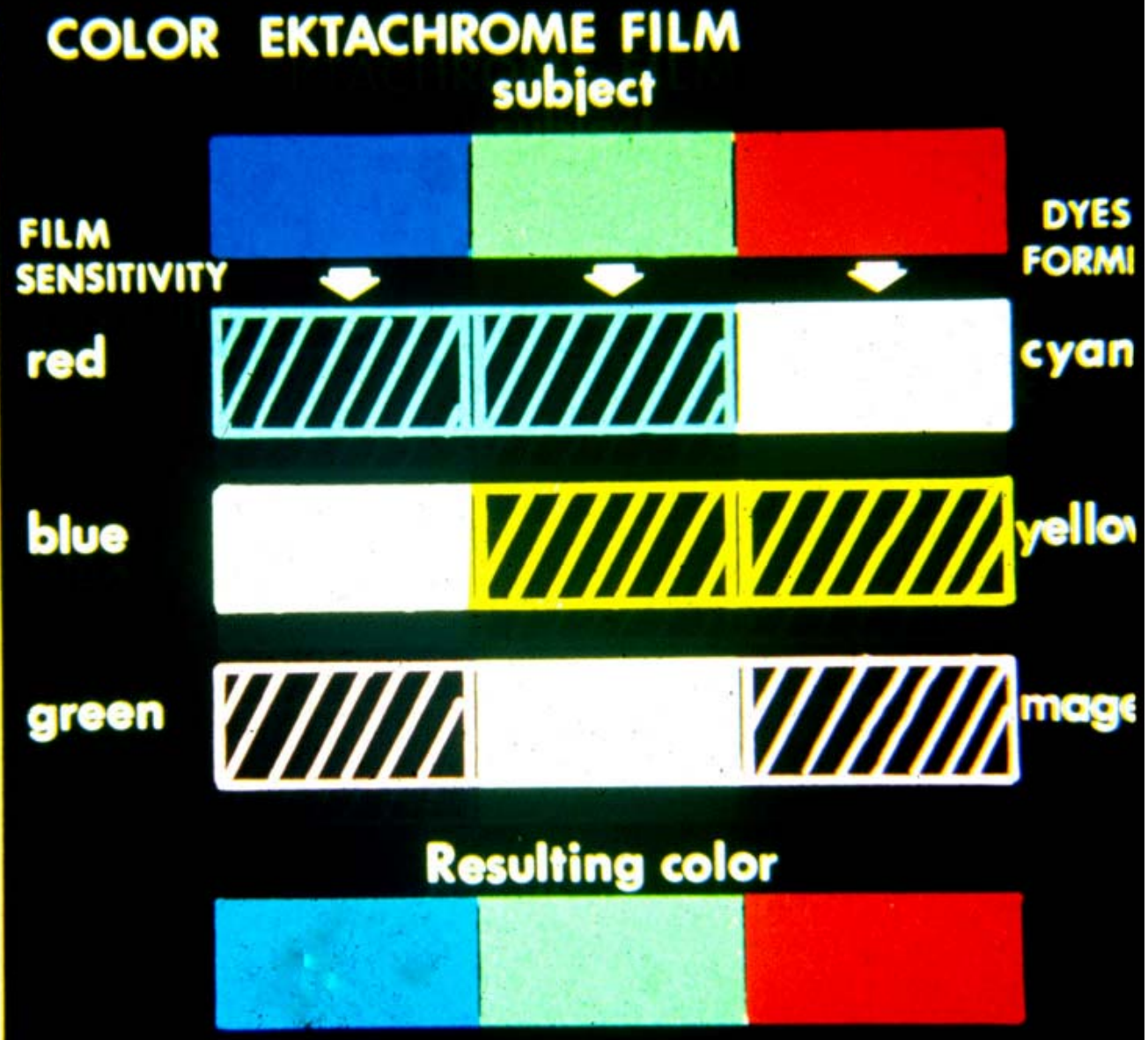
Electromagnetic Radiation



Spectral Reflectances of Three Surfaces



Sensors



photographic

Photographie panchromatique

Bande spectrale bleue

Bande spectrale bleue

Bande spectrale verte

Bande spectrale verte

Bande spectrale rouge

Bande spectrale rouge

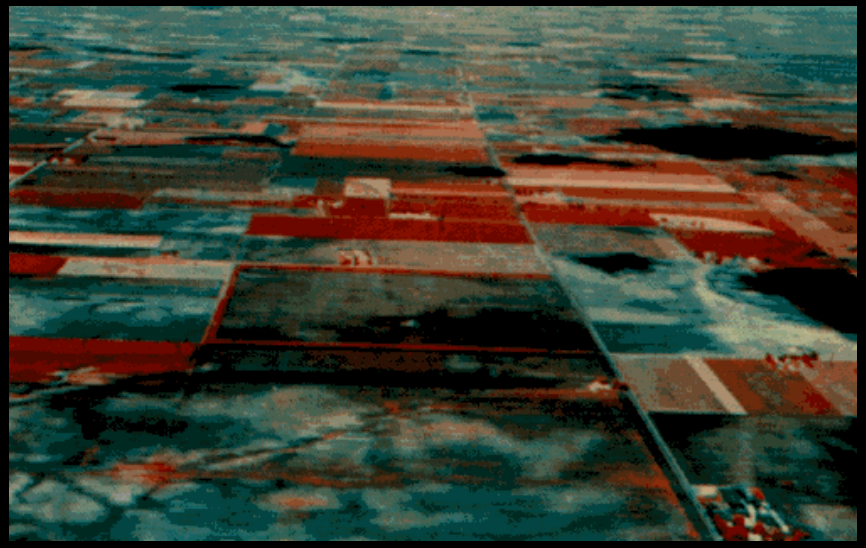
Composition couleurs naturelles

Color Composites

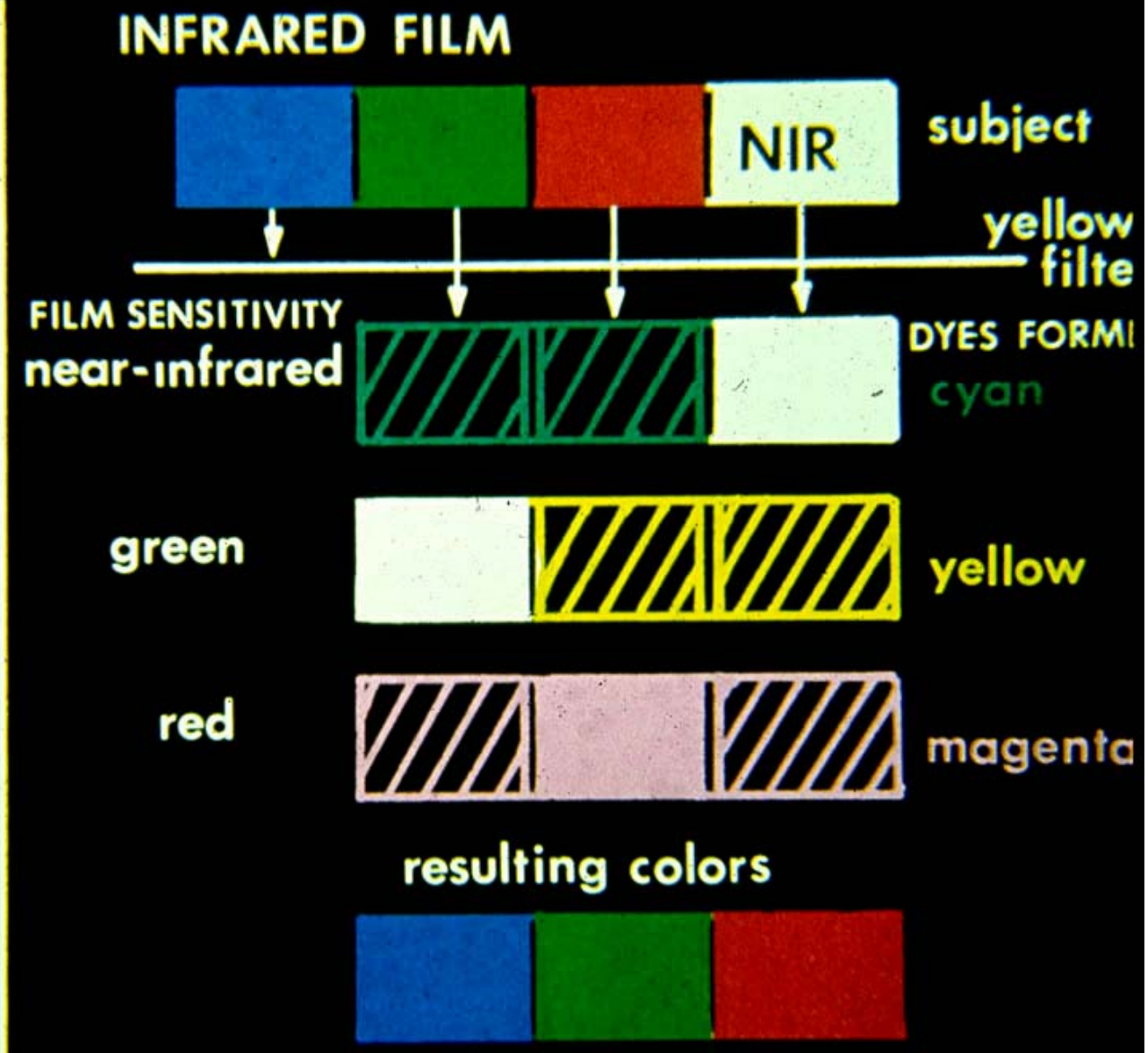
- Electronic images project each spectral band through either a red, green, or blue (RGB) color plane.
- Red, green, and blue are additive primary colors. White light is a mixture of all three colors.
- Colors in composite images form by the amount or intensity of each color that are mixed together.

Infrared (IR) Film

- 1931: Black and white IR sensitive film developed.
- 1942: Kodak patents first false color IR sensitive film.



Sensors

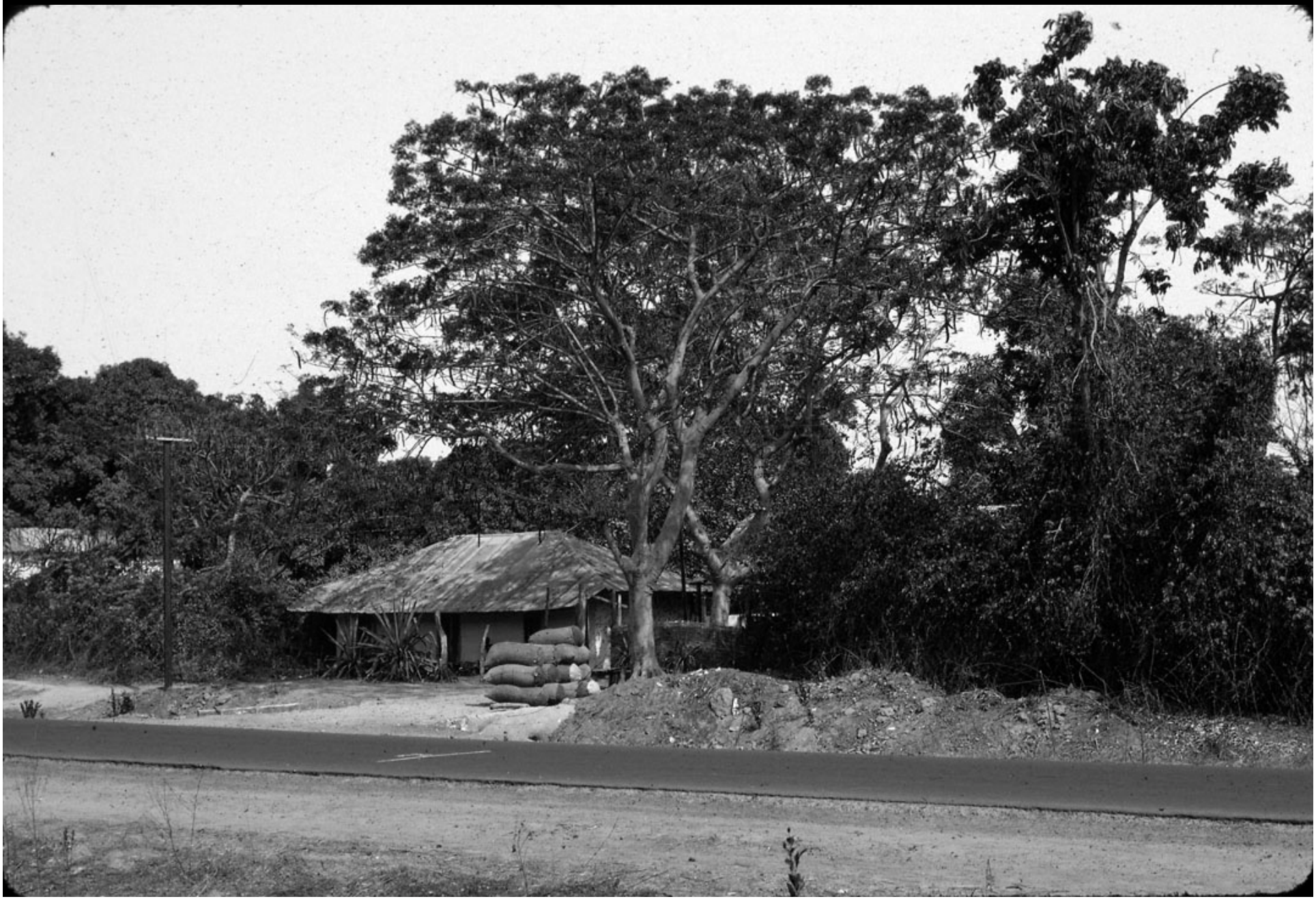


photographic

Bande infrarouge

Composition couleur infrarouge

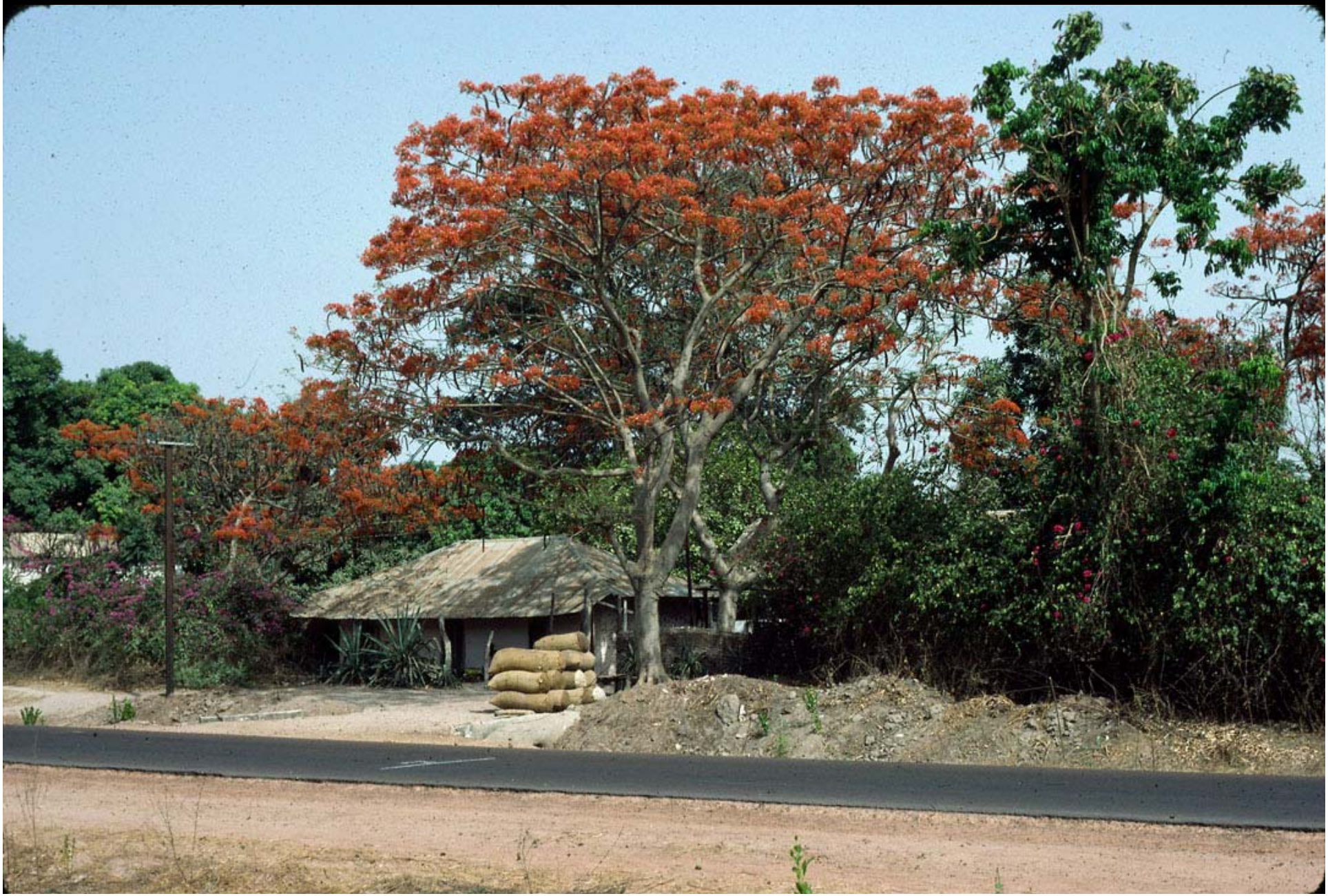
Bande bleue



Bande verte

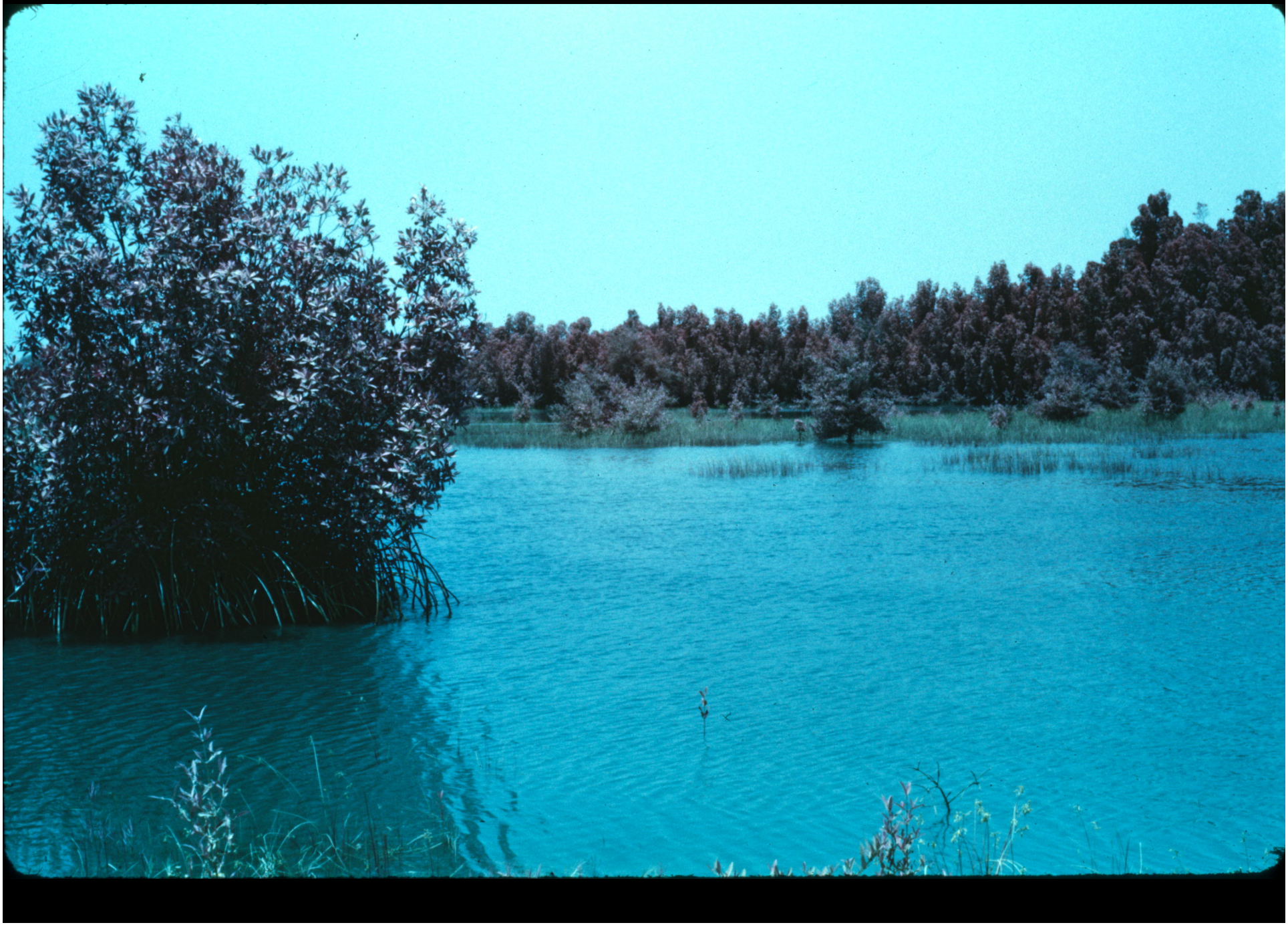
Bande rouge

Composition couleurs naturelles



Bande infrarouge

Composition couleur infrarouge



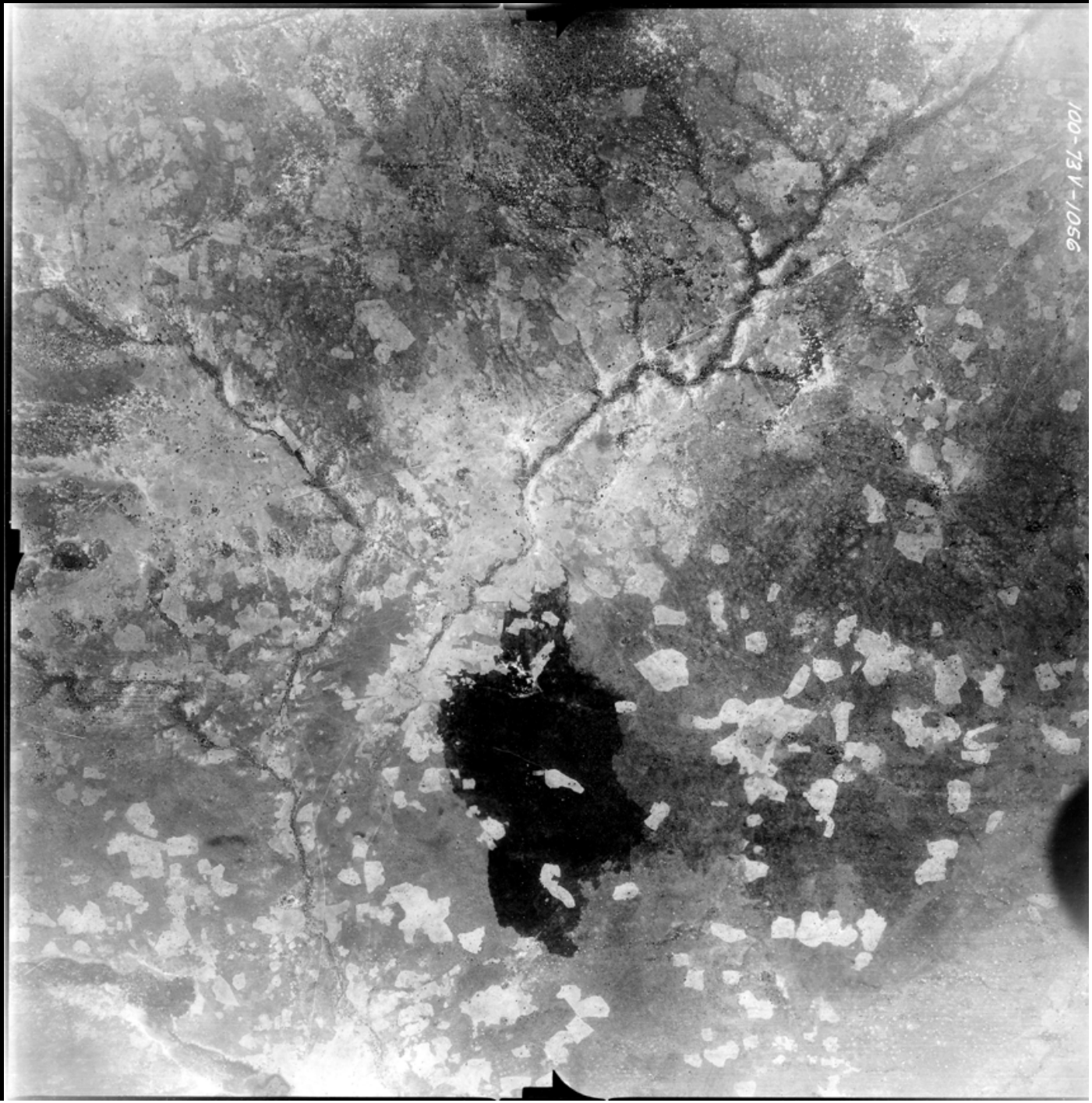
Photographie aérienne

- produits filmés, vidéos ou numériques
- photographies et images
- large gamme d’échelles
- systèmes photographiques, vidéos ou numériques
- sensibilité spectral large
- résolution très haute à moyenne
- nombreuses applications

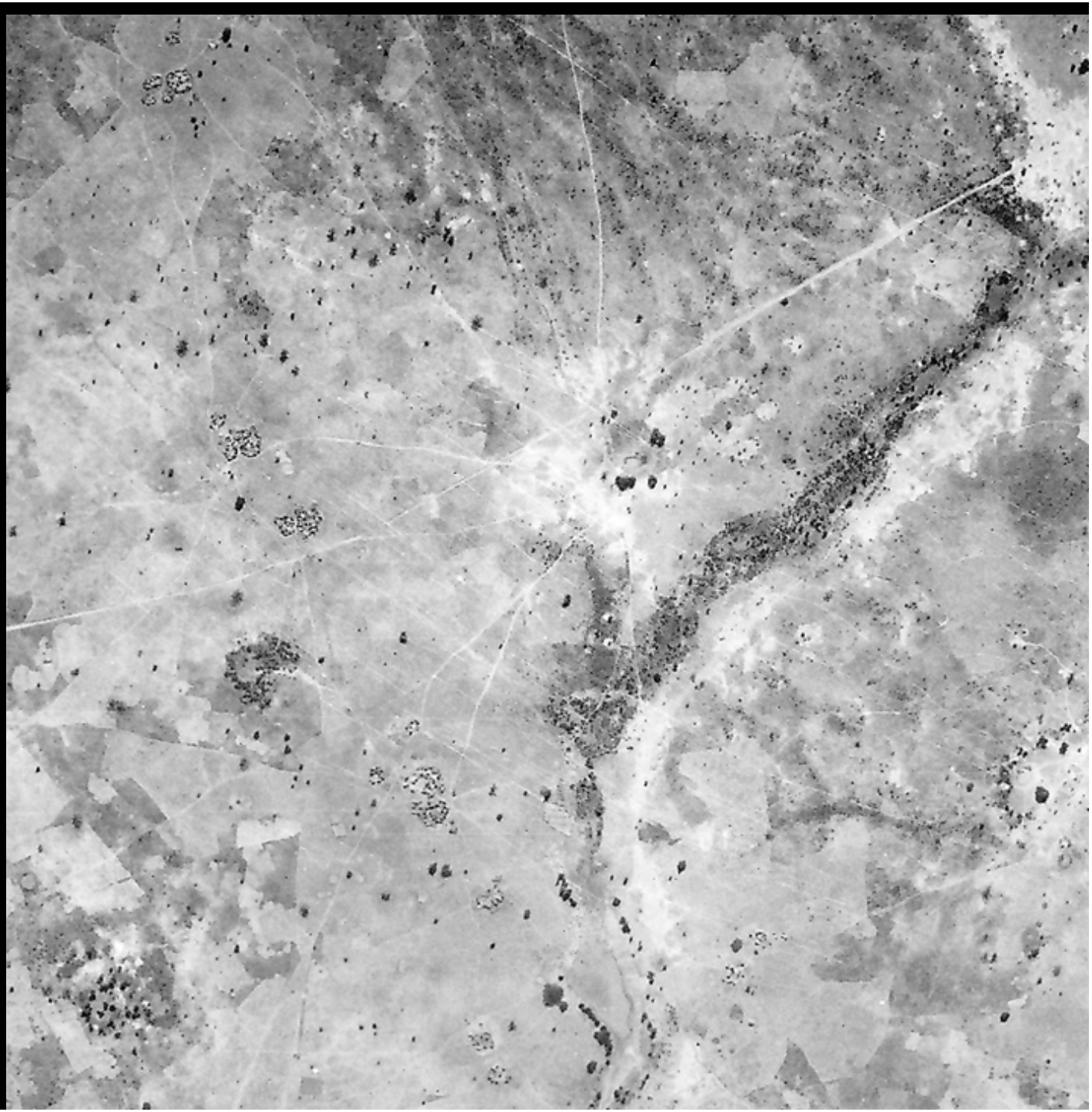
Photographie Aérienne:

Dakar en 1942

Plateau Central - Photo Aérienne de 1943



Plateau Central - Photo Aérienne de 1943



D
E
E
B
D
A
C

Terroirs agricoles au Sénégal –

Photo Aérienne en format vertical

Terroirs agricoles au Sénégal –

Photo Aérienne en format oblique

photointerpretation

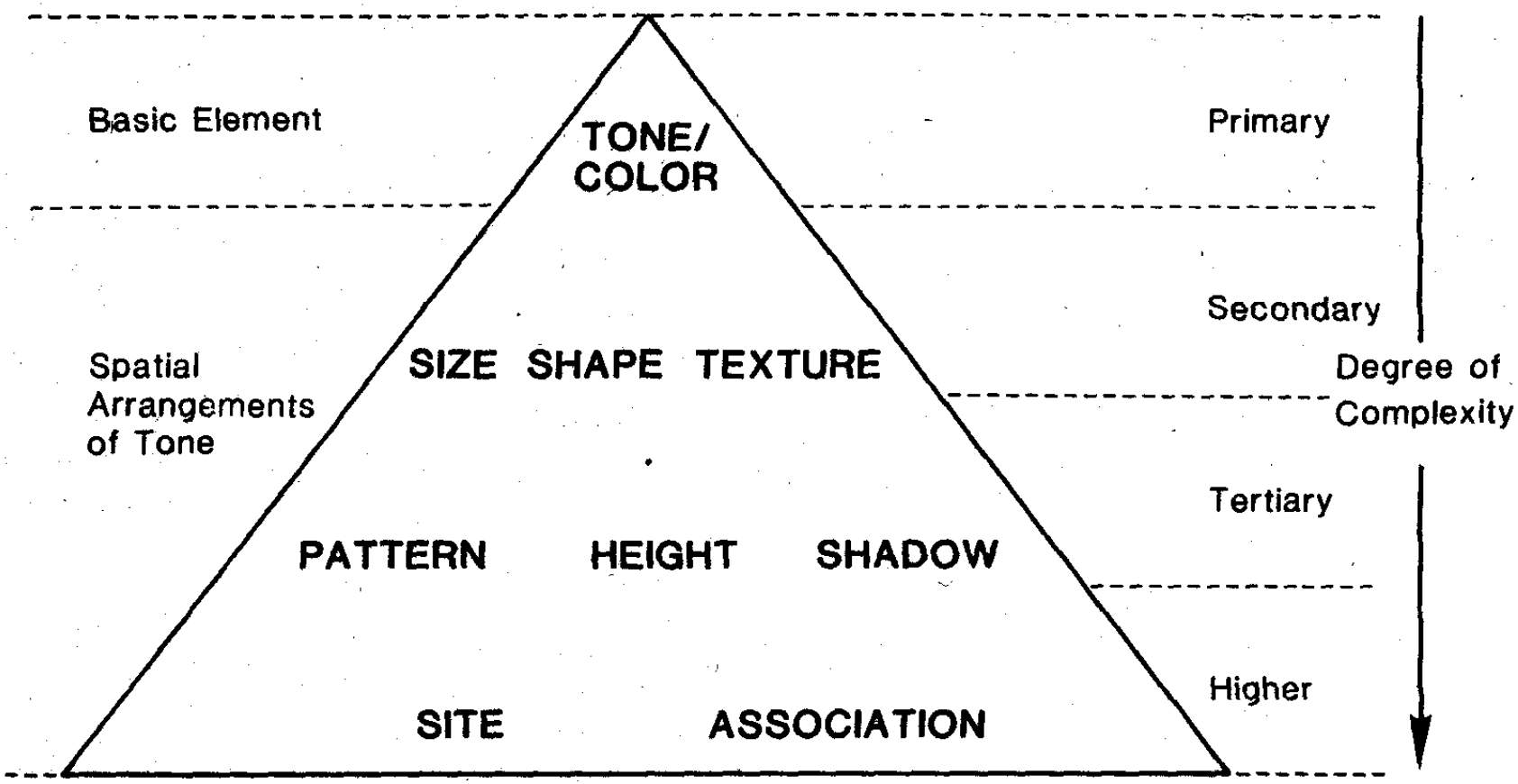
- *Photointerpretation* is the practice of deriving useful information from photographs and images
- In remote sensing, we refer to the same process as *image interpretation*

Elements of Image Interpretation

- **Tone**
- **Color**
- **Size**
- **Shape**
- **Texture**
- **Pattern**
- **Height**
- **Shadow**
- **Site**
- **Association**

- **Used *together* to understand and recognize visual signatures of features and objects;**
- **Often applied implicitly, but an explicit vocabulary permits clear documentation and discussion.**

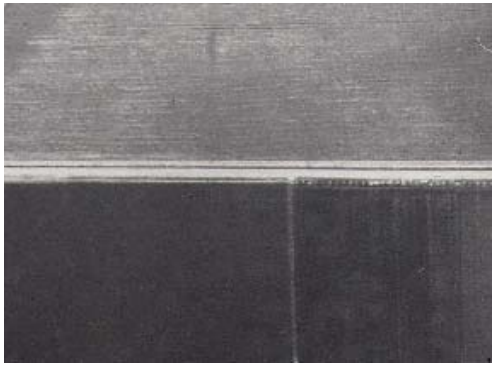
PRIMARY ORDERING OF IMAGE ELEMENTS FUNDAMENTAL TO THE ANALYSIS PROCESS

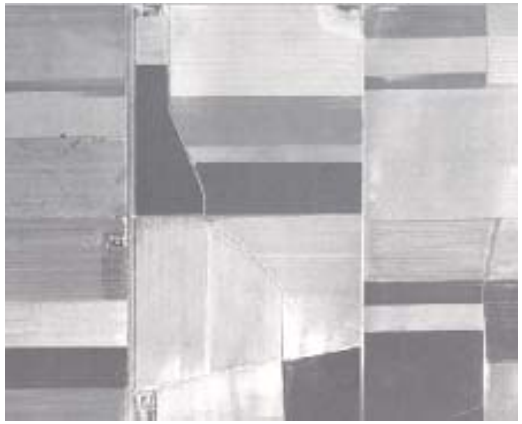


GF

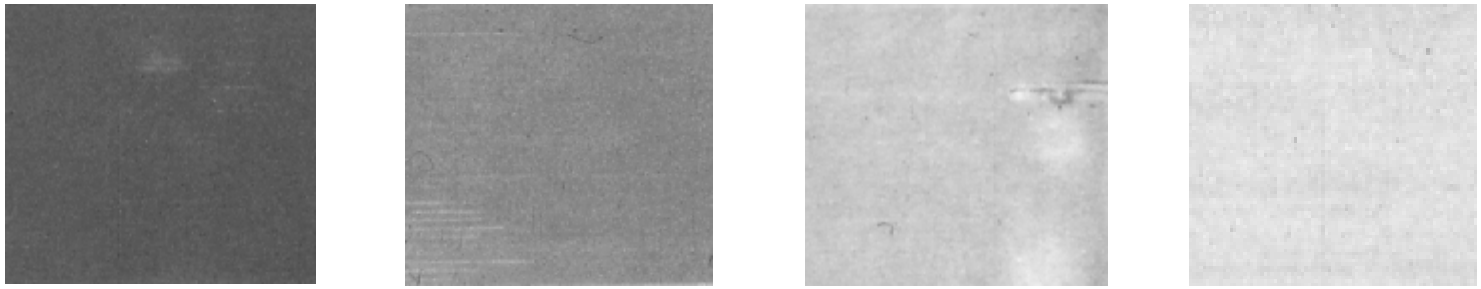
tone

elements of image interpretation





- **Specifies brightness of the surface, relative to other features;**



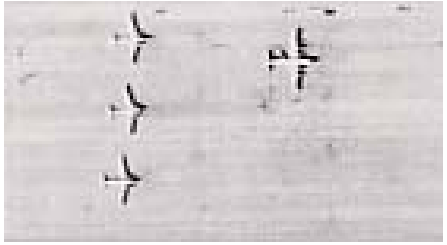
DARK

LIGHT

image tone

shape

Elements of Image Interpretation



- **Often one of the most distinctive characteristics of an object;**

A

B

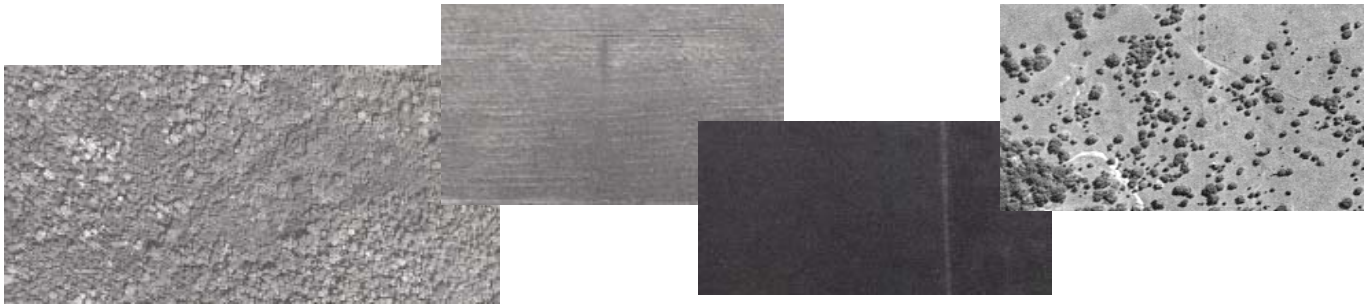
C

D

shape

texture

Elements of Image Interpretation



- Roughness & irregularities of image tone;
- Usually caused by microshadows;
- Usually one of the most important visual clues.

SMOOTH; EVEN

MOTTLED

COARSE

Image Texture

Pattern*

elements of image interpretation

Pattern **is the distinctive appearance of a region caused by the systematic arrangement of components within the region. Orchards, for example, exhibit characteristic patterns because of the systematic arrangement of trees in a regular alignment.**

*** En français: motif récurrent**

pattern

elements of image interpretation

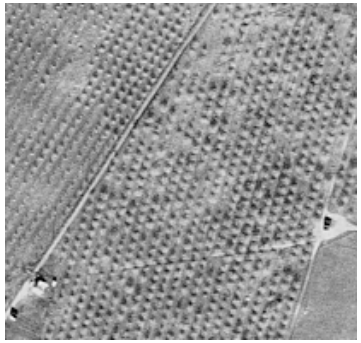
- Patterns usually originate from functional relationships between components;
- For example, the patterns of orchards arise because of the necessity to move equipment within the orchard, and the need to minimize competition between trees for moisture and nutrients.

pattern

elements of image interpretation

- **Patterns usually originate from functional relationships between components**

A



B

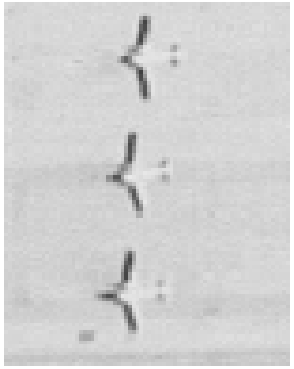
C

D

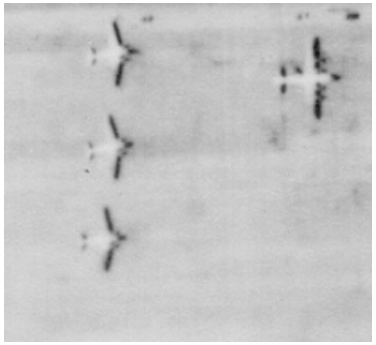
Image Pattern

shadow

elements of image interpretation



- **Shadows can identify features not recognizable solely from an overhead view;**
- **Shadows can enhance edges of features;**
- **Shadows can contribute to distinctive textures.**



shadow

association

elements of image interpretation

Features group together spatially because of functional relationships, so the presence of one component implies the presence of associated components.

association

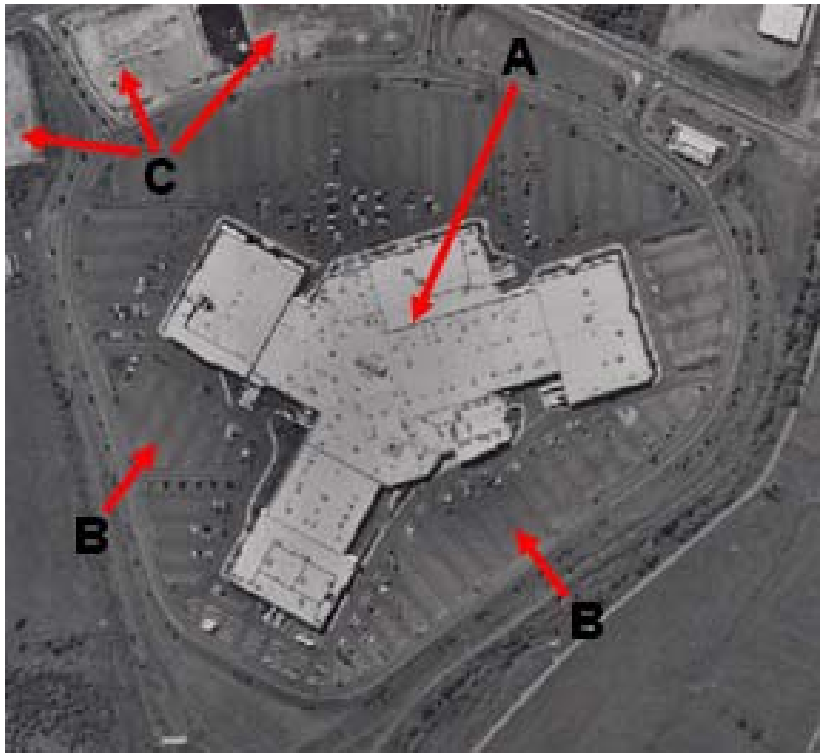
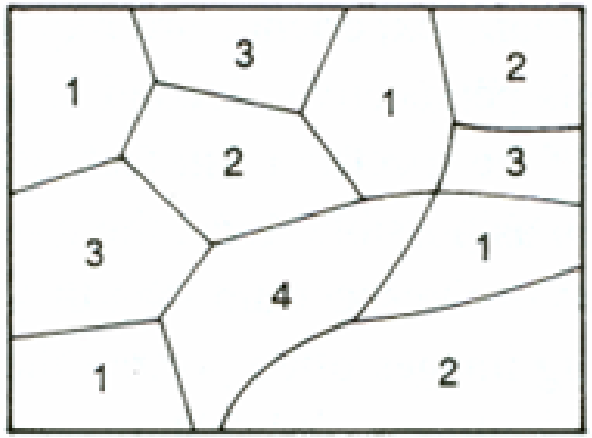
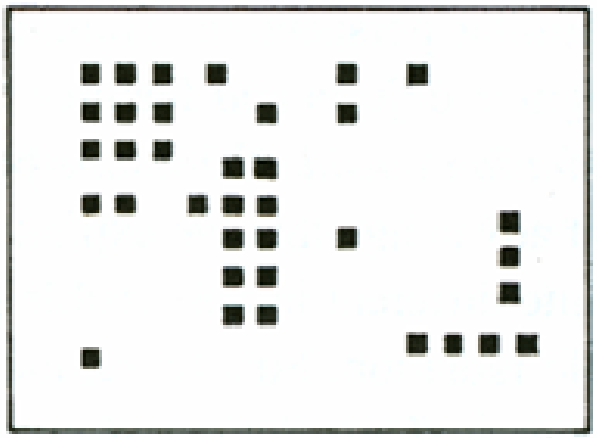


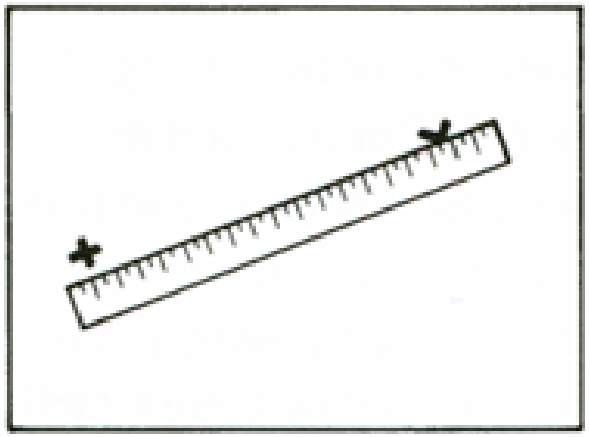
image interpretation tasks



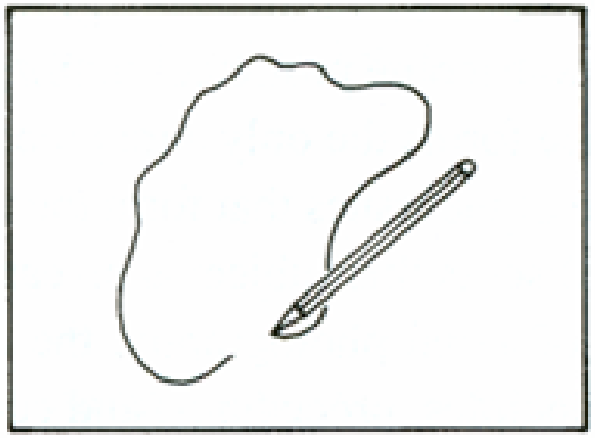
classification



enumeration



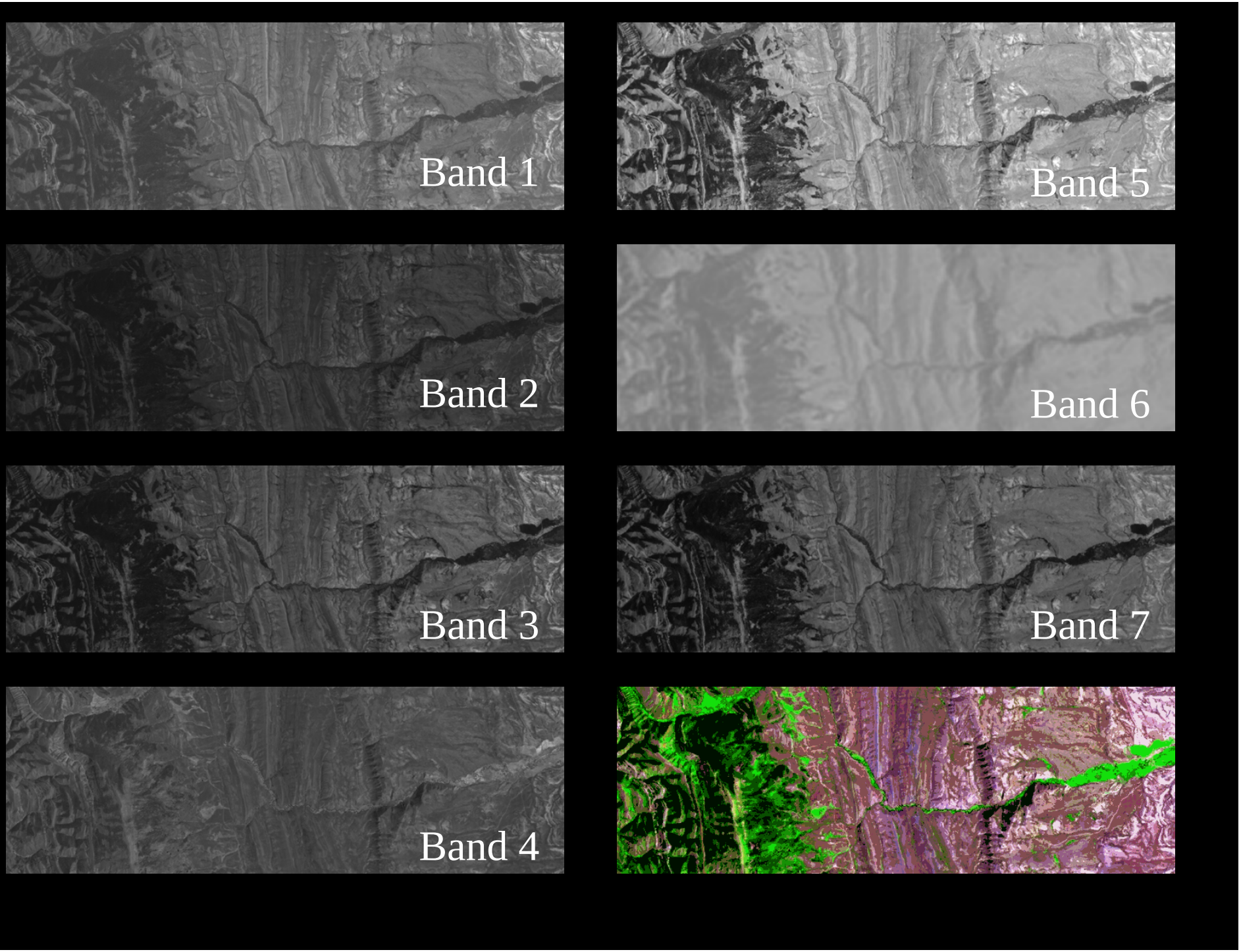
mensuration



delineation

Landsat TM

Band	Wavelength (micrometers)		Resolution (m)
Band 1	0.45-0.52	Blue	30
Band 2	0.52-0.60	Green	30
Band 3	0.63-0.69	Red	30
Band 4	0.76-0.90	NIR	30
Band 5	1.55-1.75	MIR	30
Band 6	10.40-12.50	TIR	120
Band 7	2.08-2.35	MIR	30


Band 1
Band 5
Band 2
Band 6
Band 3
Band 7
Band 4

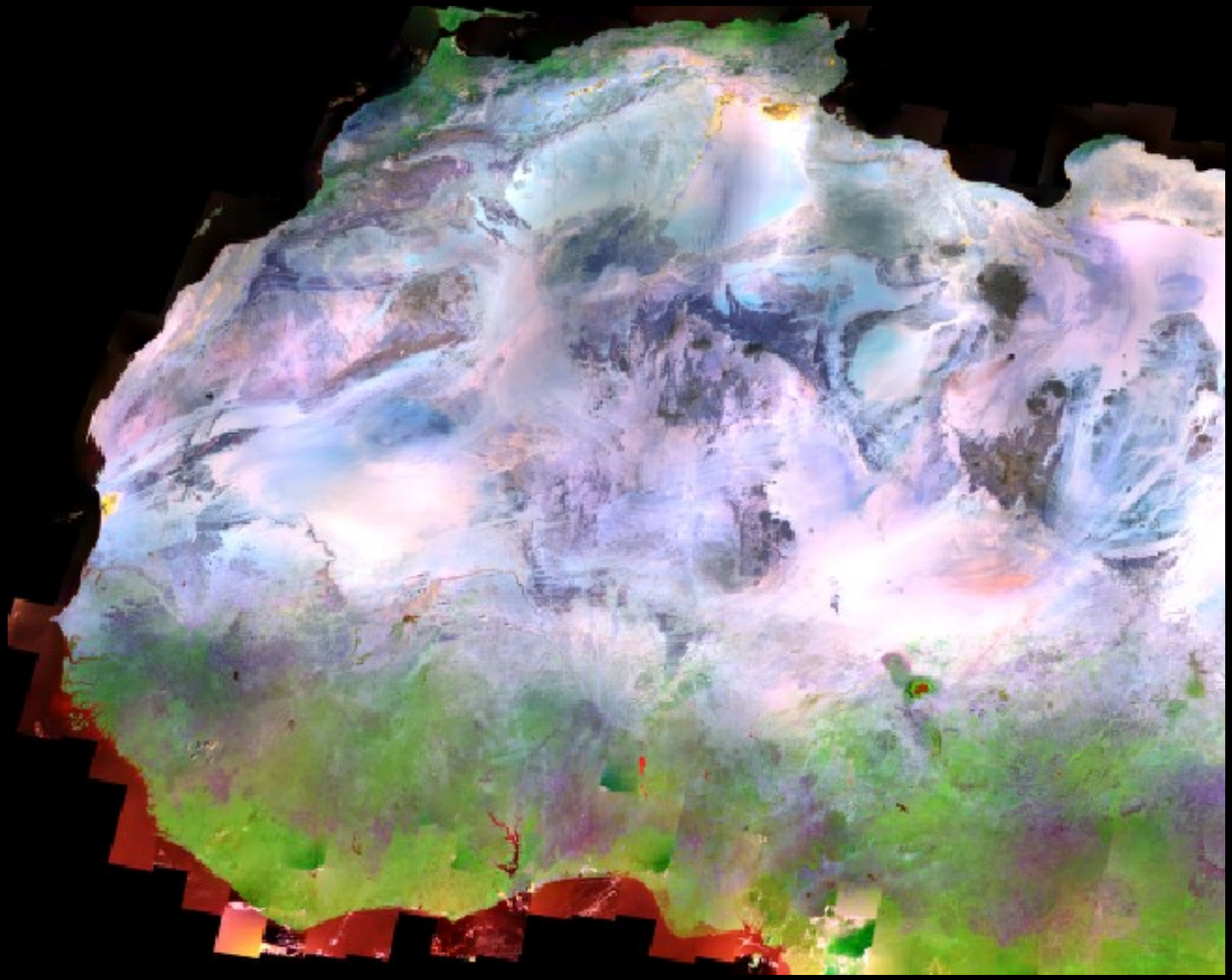
Landsat TM Band Applications

- Band 1 (0.45 - 0.52 blue): soil/vegetation discrimination; bathymetry/coastal mapping; cultural/urban feature identification
- Band 2 (0.52 - 0.60 green): green vegetation mapping (measures reflectance peak); cultural/urban feature identification
- Band 3 (0.63 - 0.69 red): vegetated vs. non-vegetated and plant species discrimination (plant chlorophyll absorption); cultural/urban feature identification

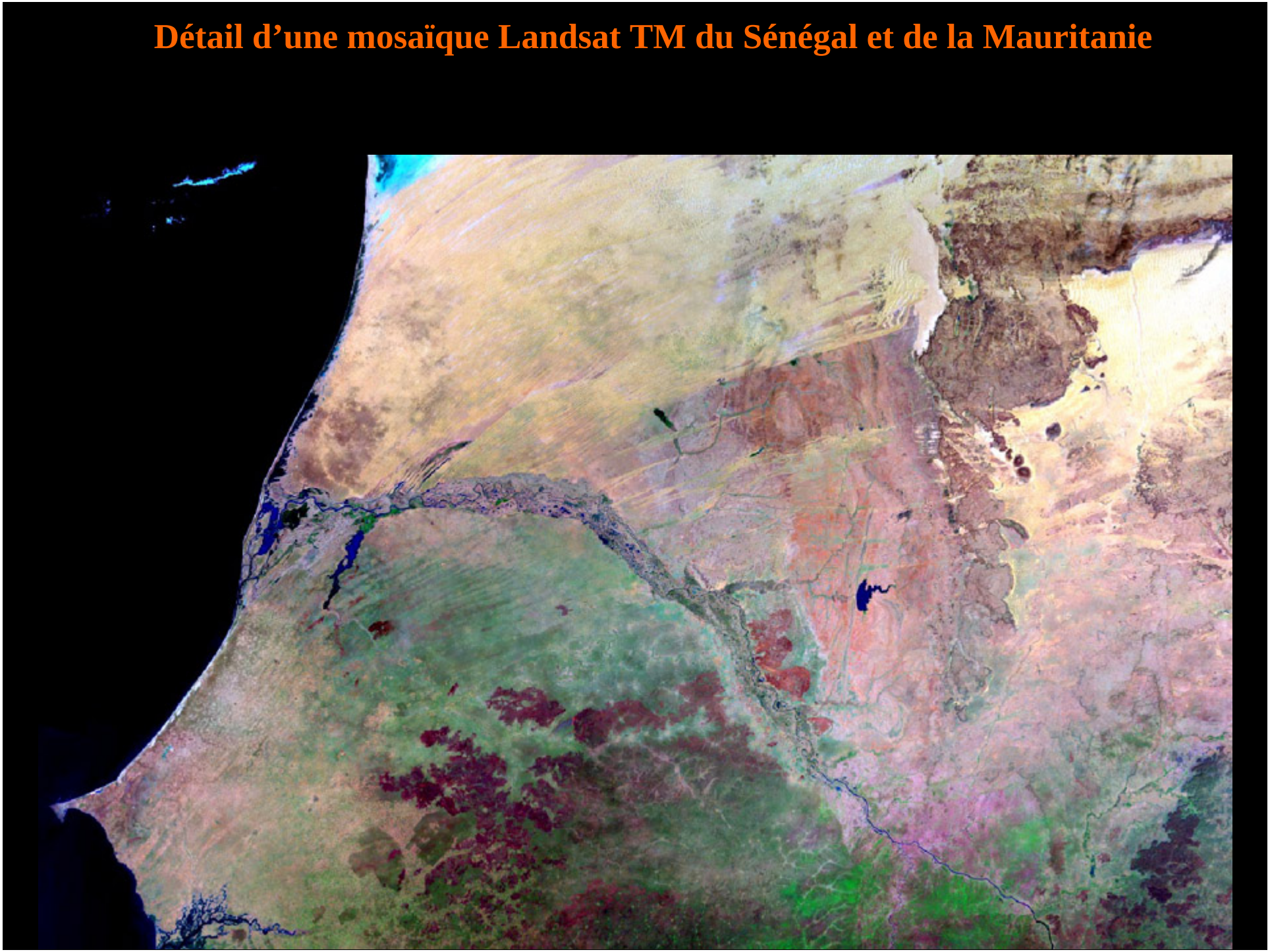
Landsat TM Band Applications

- Band 4 (0.76 - 0.90 NIR): identification of plant/vegetation types, health, and biomass content; water body delineation; soil moisture
- Band 5 (1.55 - 1.75 Mid-IR): sensitive to moisture in soil and vegetation; discriminating snow from clouds
- Band 6 (10.4 - 12.5 TIR): vegetation stress and soil moisture discrimination related to thermal radiation; thermal mapping (urban, water)
- Band 7 (2.08 - 2.35 Mid-IR): discrimination of mineral and rock types; sensitive to vegetation moisture content

Mosaïque Landsat TM de l ’Afrique du Nord et de l ’Ouest

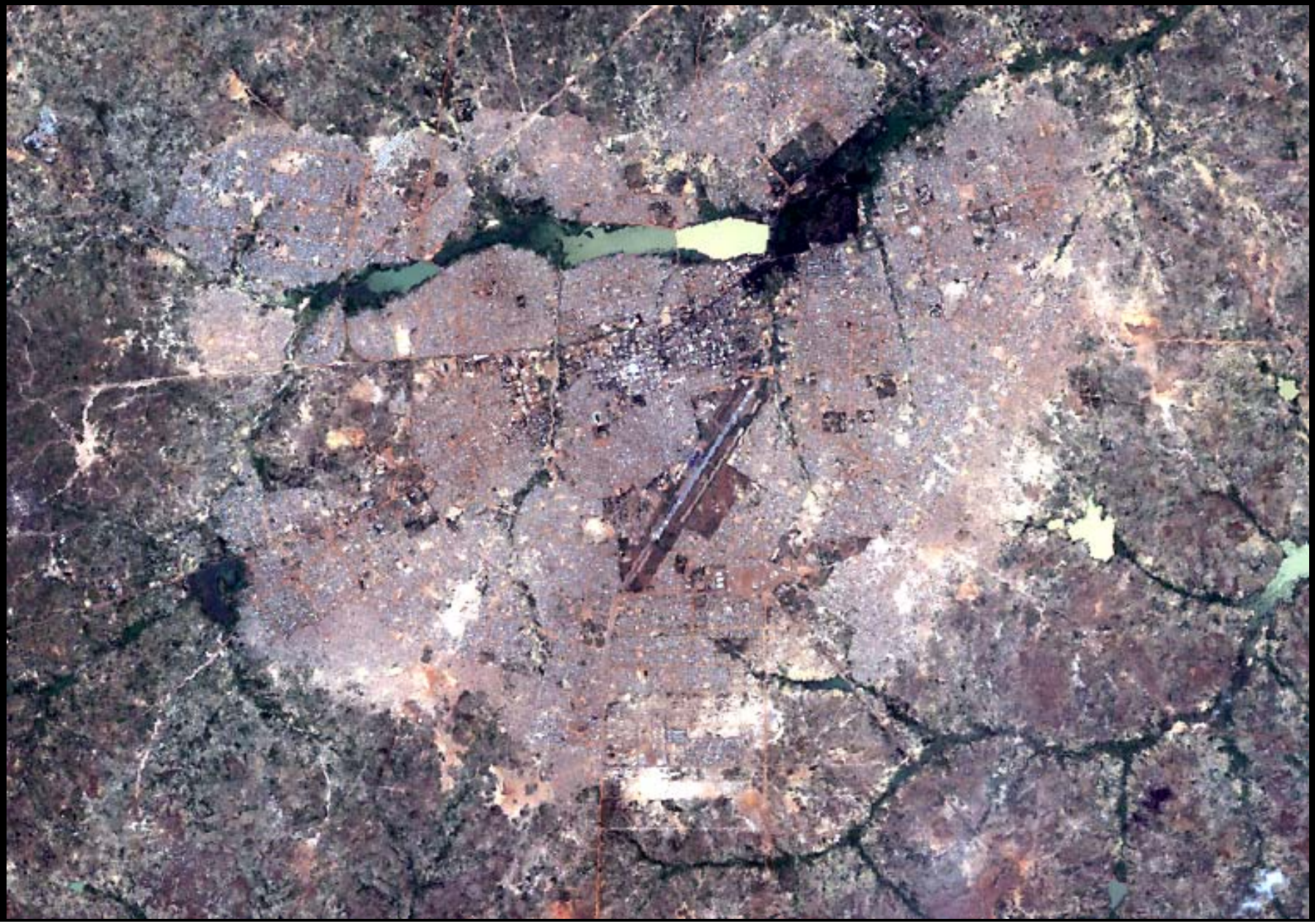


Détail d’une mosaïque Landsat TM du Sénégal et de la Mauritanie



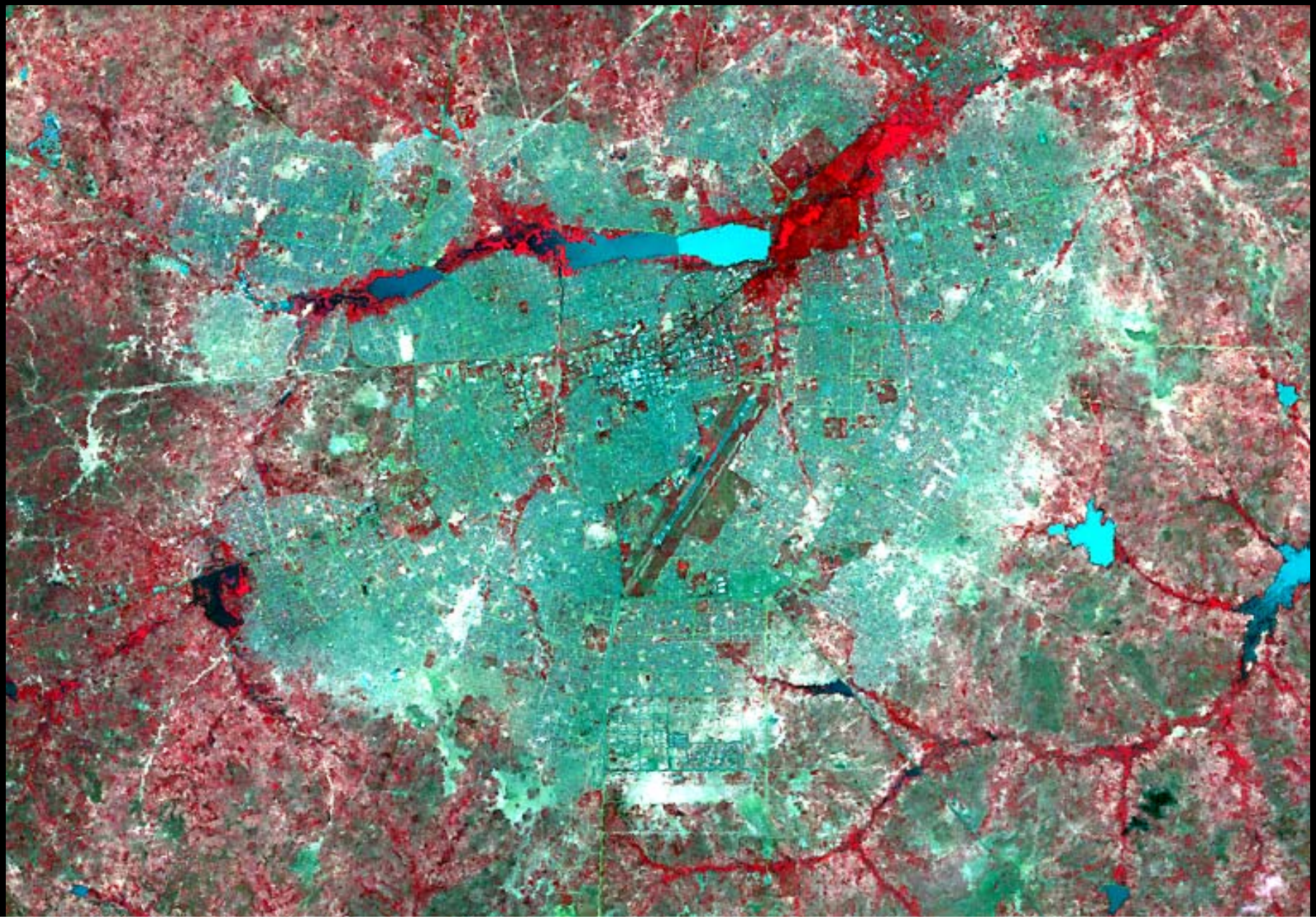
Ouagadougou 1999 – Vue de Landsat en couleurs naturelles

(bandes ETM 1, 2, 3)



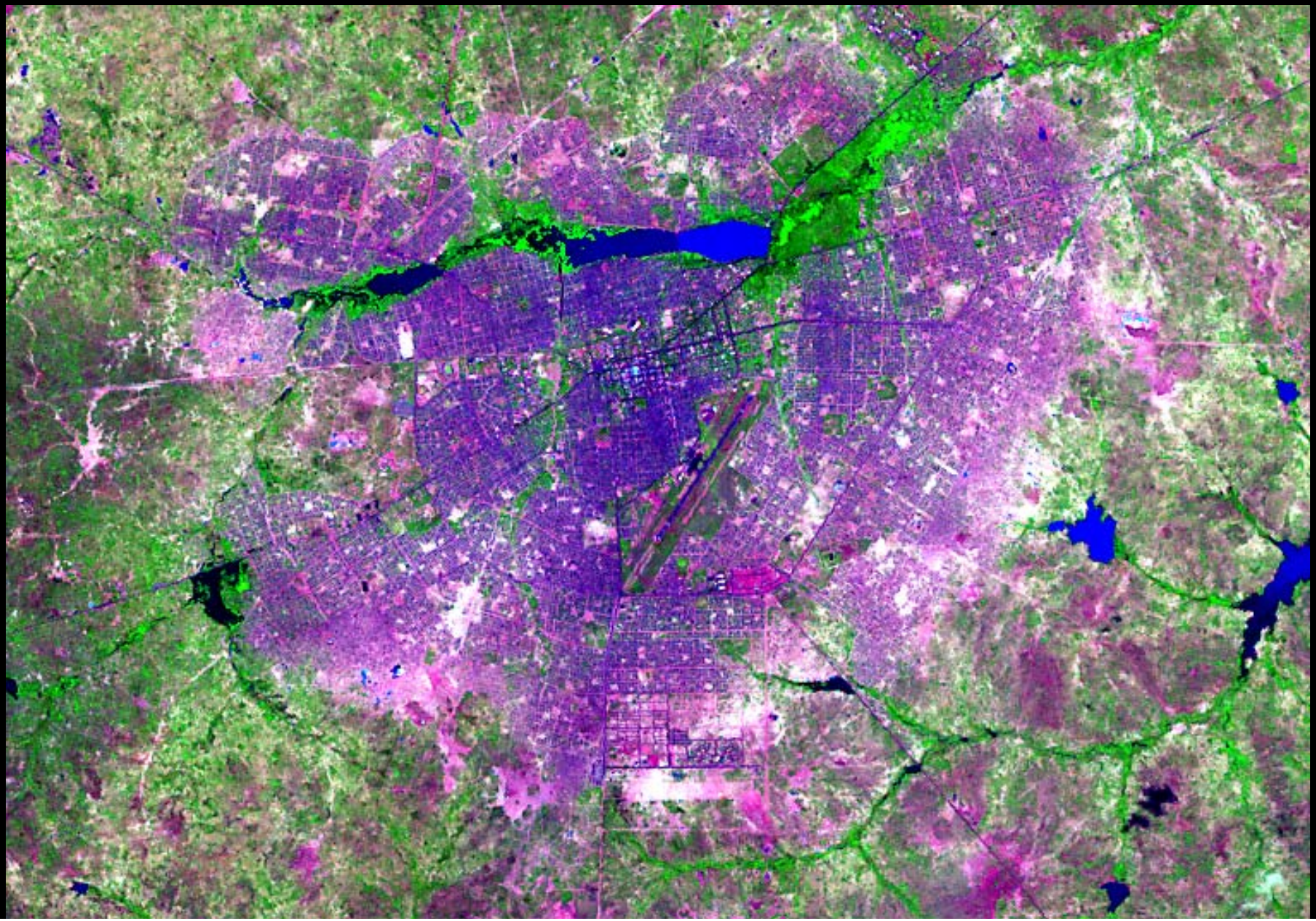
Ouagadougou 1999 – Vue de Landsat en couleurs infrarouges

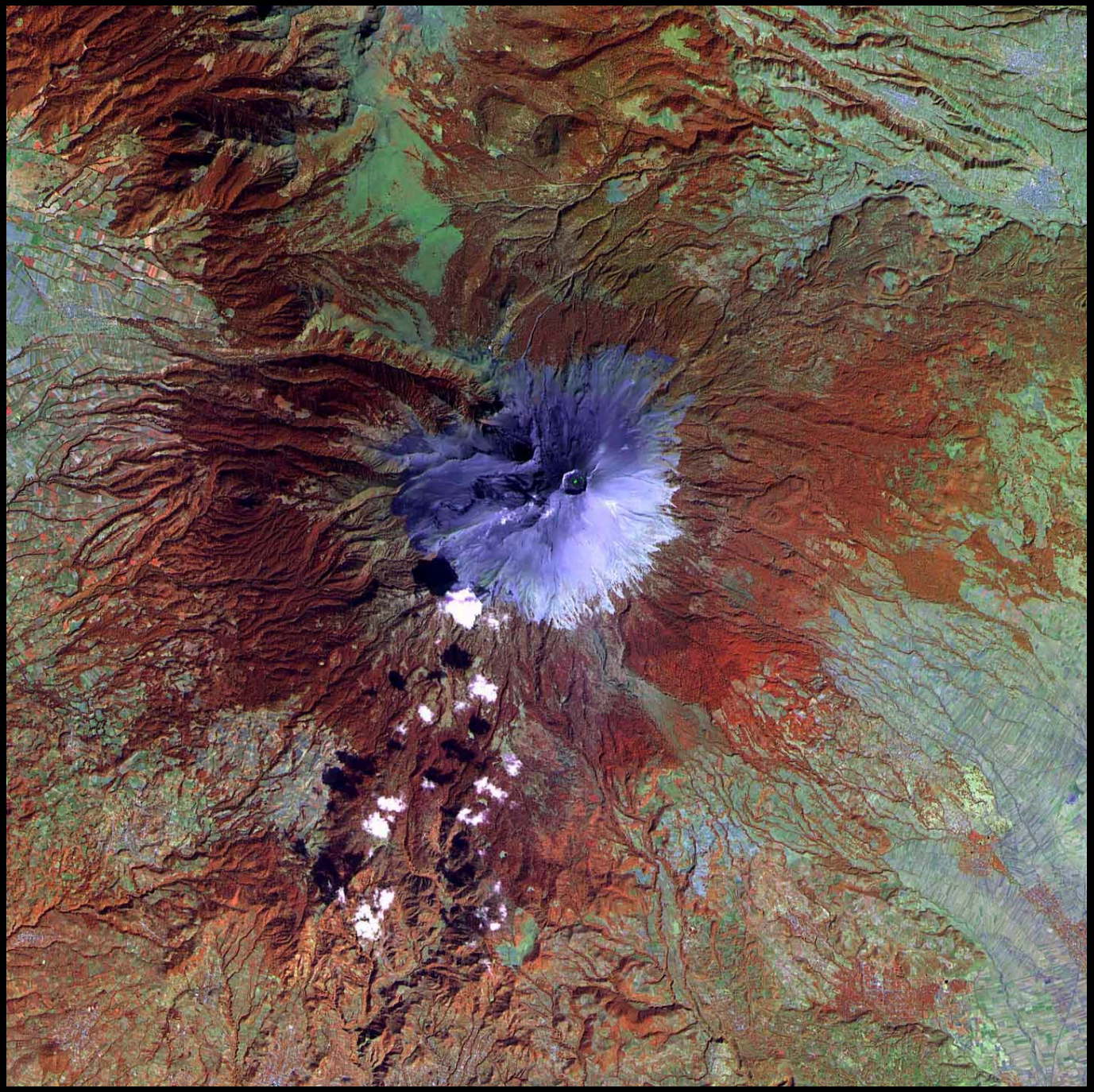
(bandes ETM: 2, 3, 4)



Ouagadougou 1999 – Vue de Landsat en couleurs infrarouges

(bandes ETM: 3, 4, 5)



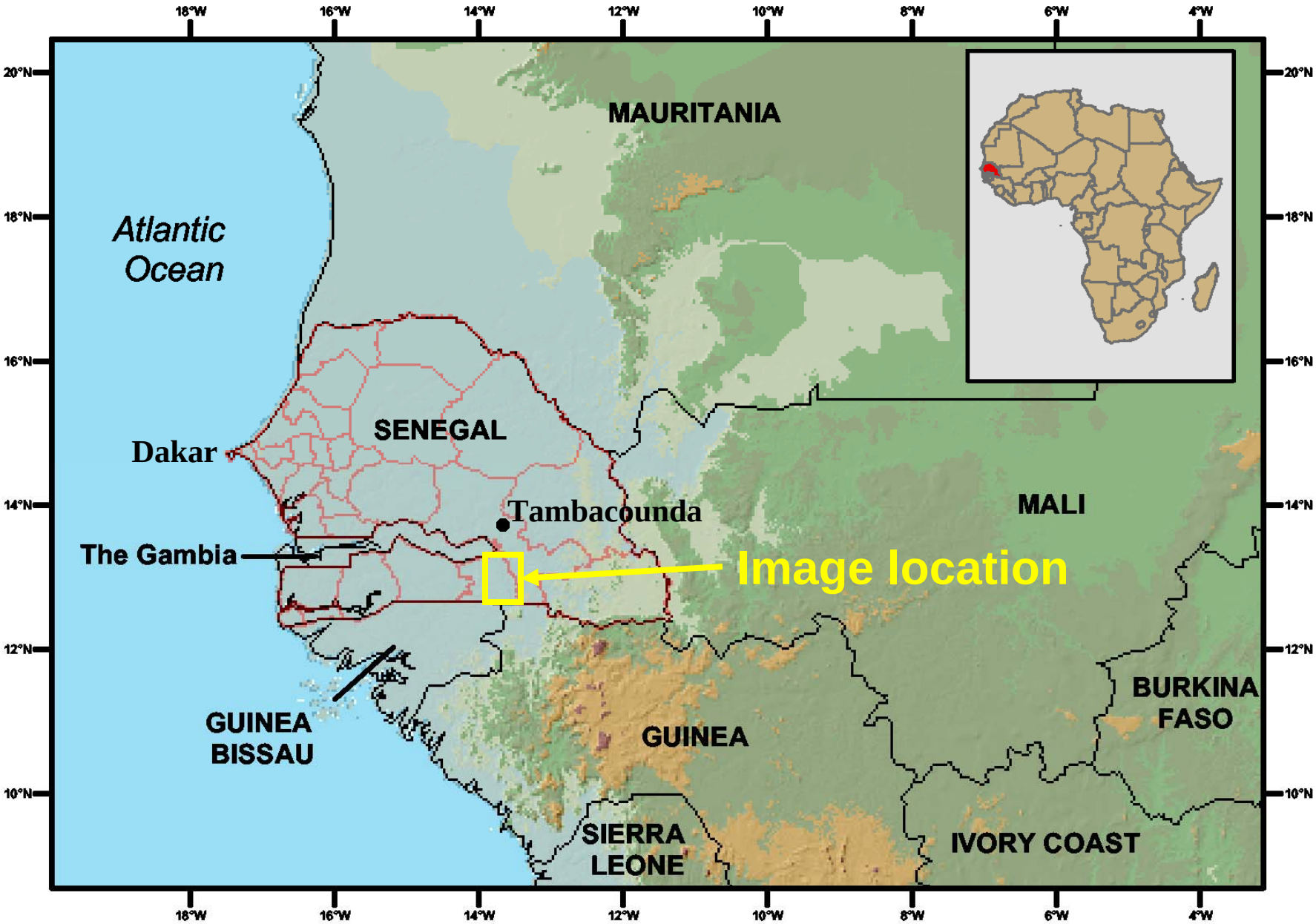


Popocatepetl Volcano

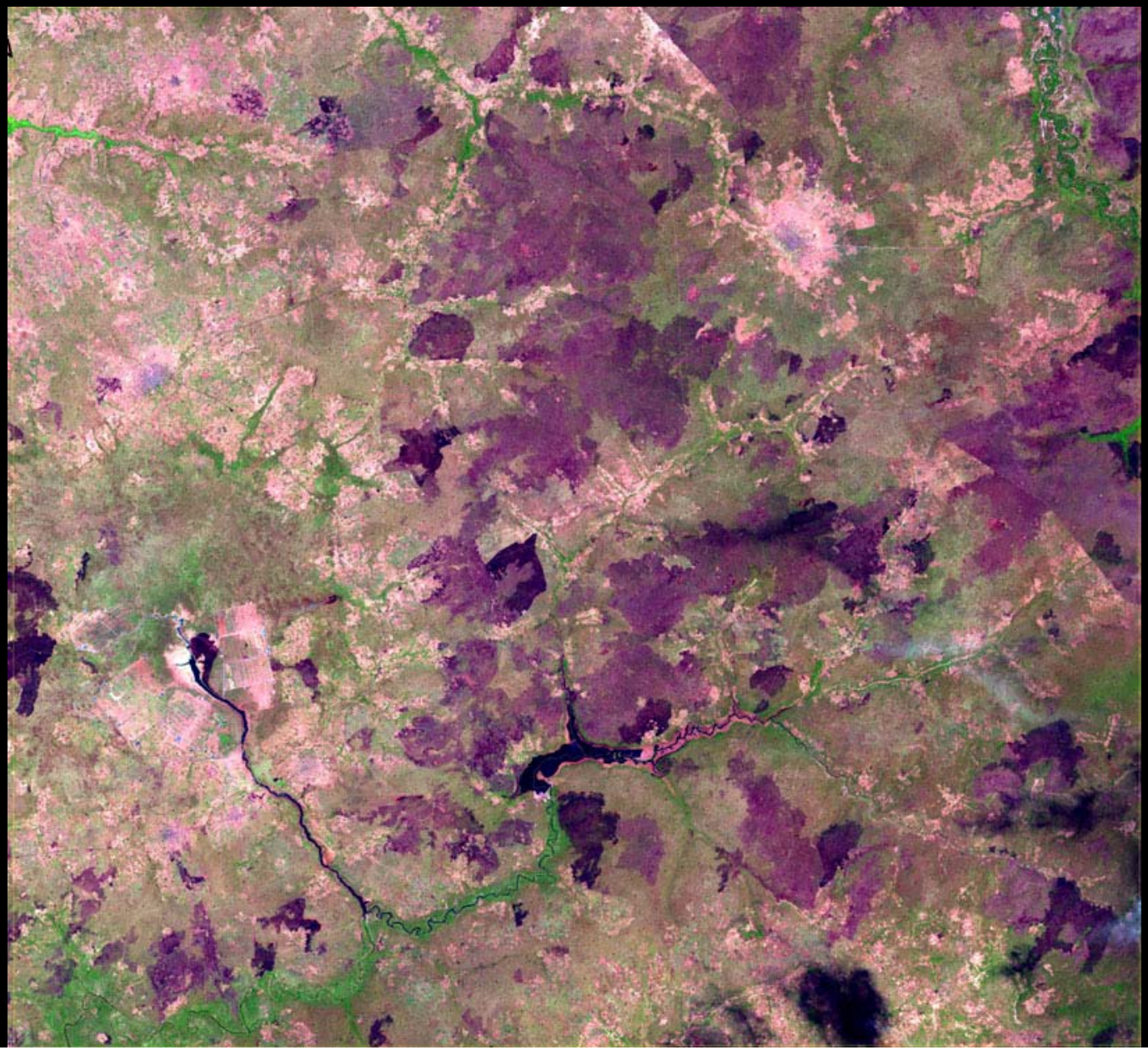
Dec. 22, 2000

SPOT 4 HRV

Image IKONOS, 1 m pan: La Colisée à Rome

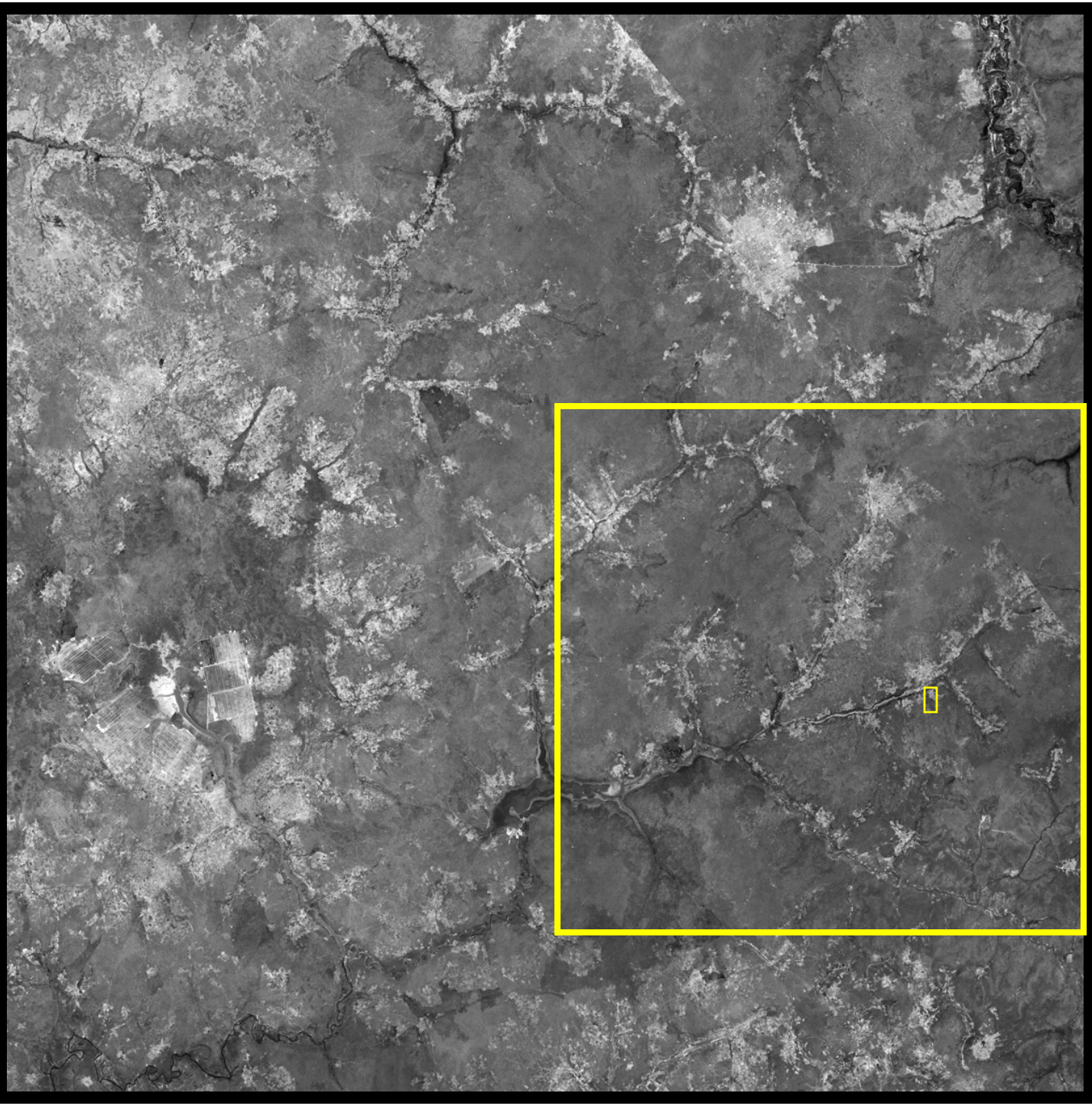

18°W
16°W
14°W
12°W
10°W
8°W
6°W
4°W
20°N
18°N
16°N
14°N
12°N
10°N
Atlantic Ocean
MAURITANIA
SENEGAL
Dakar
Tambacounda
The Gambia
MALI
Image location
GUINEA BISSAU
GUINEA
BURKINA FASO
SIERRA LEONE
IVORY COAST

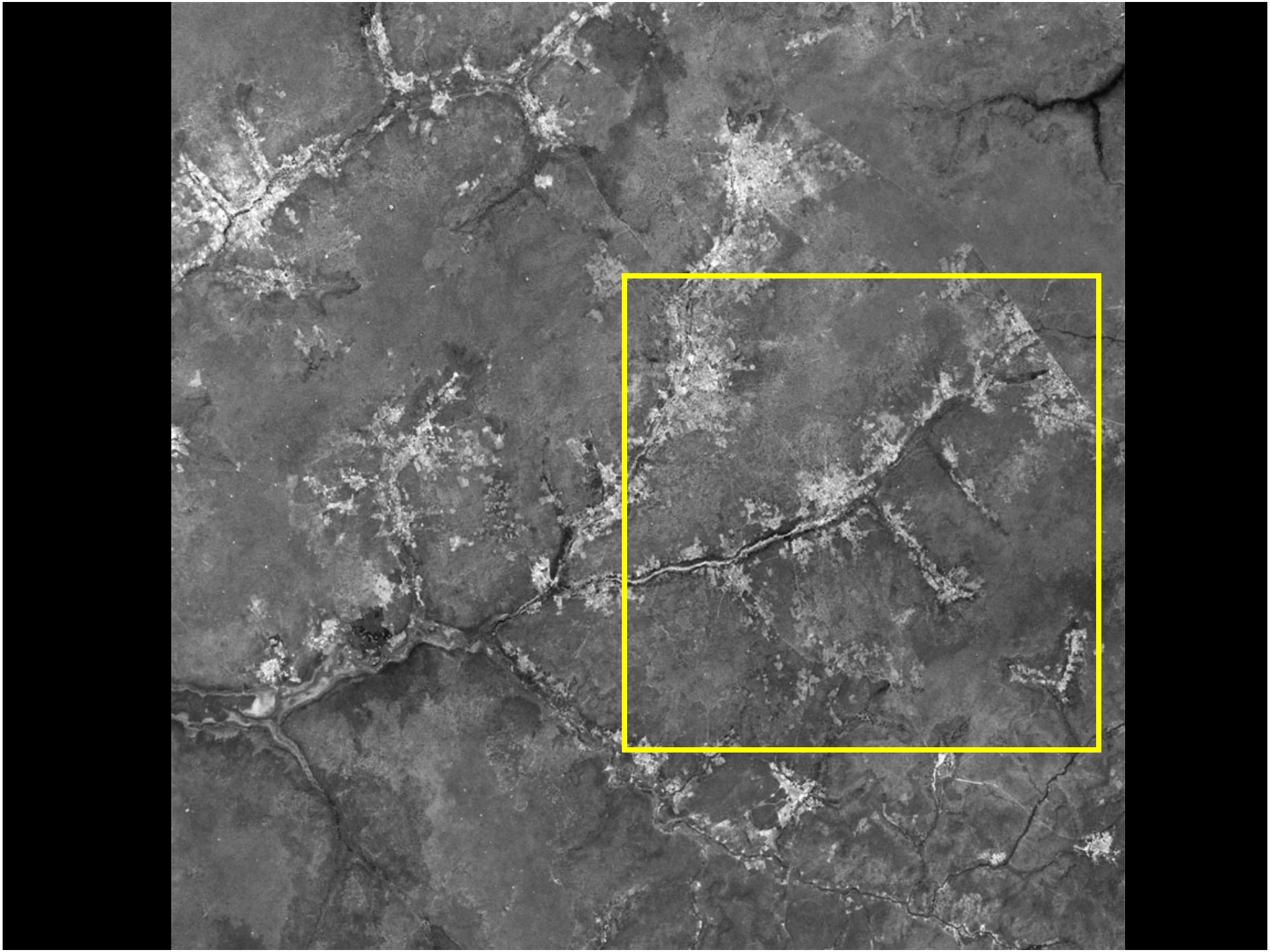
Landsat ETM+ 16 December 2002
Velingara, Senegal

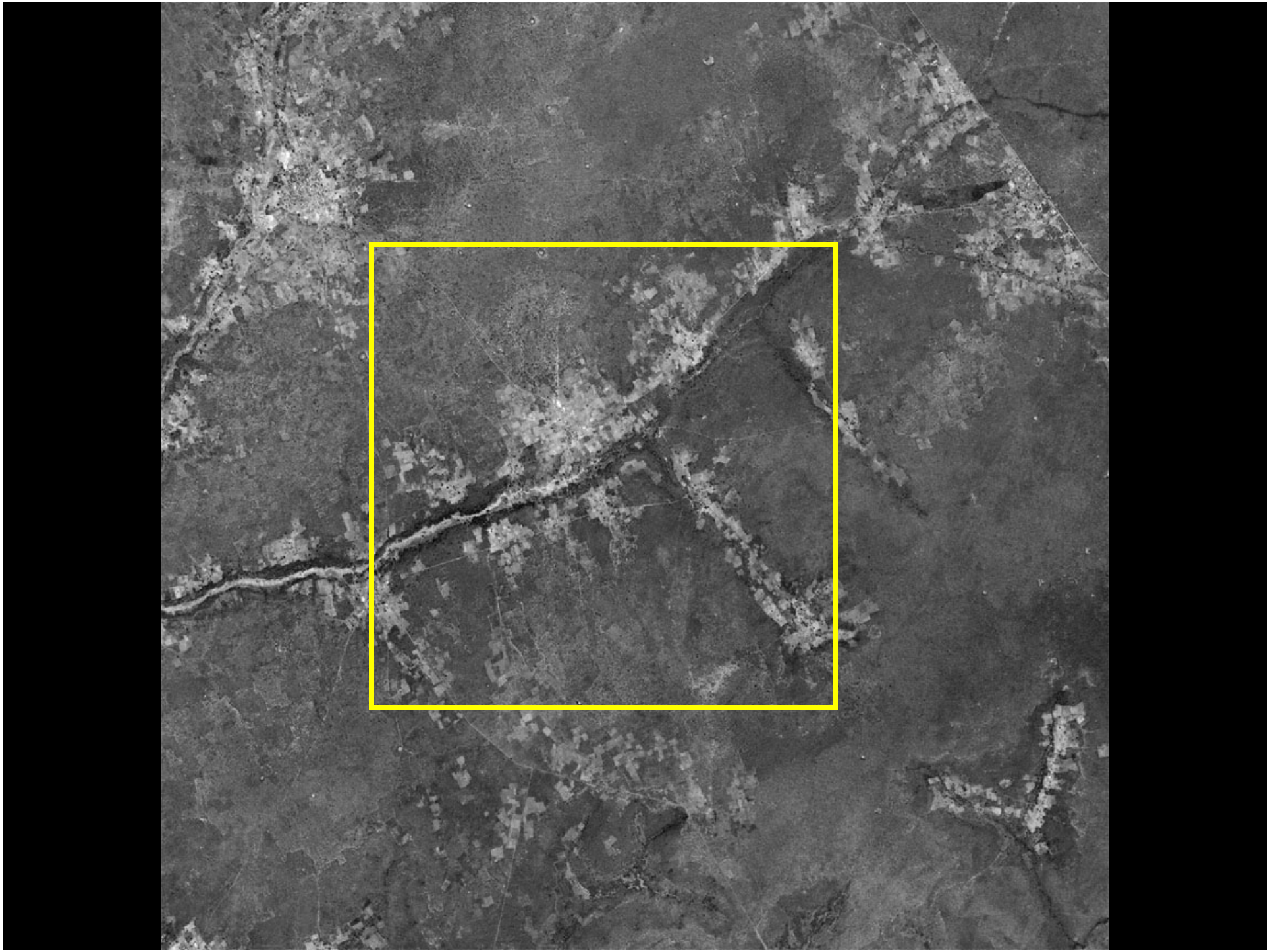


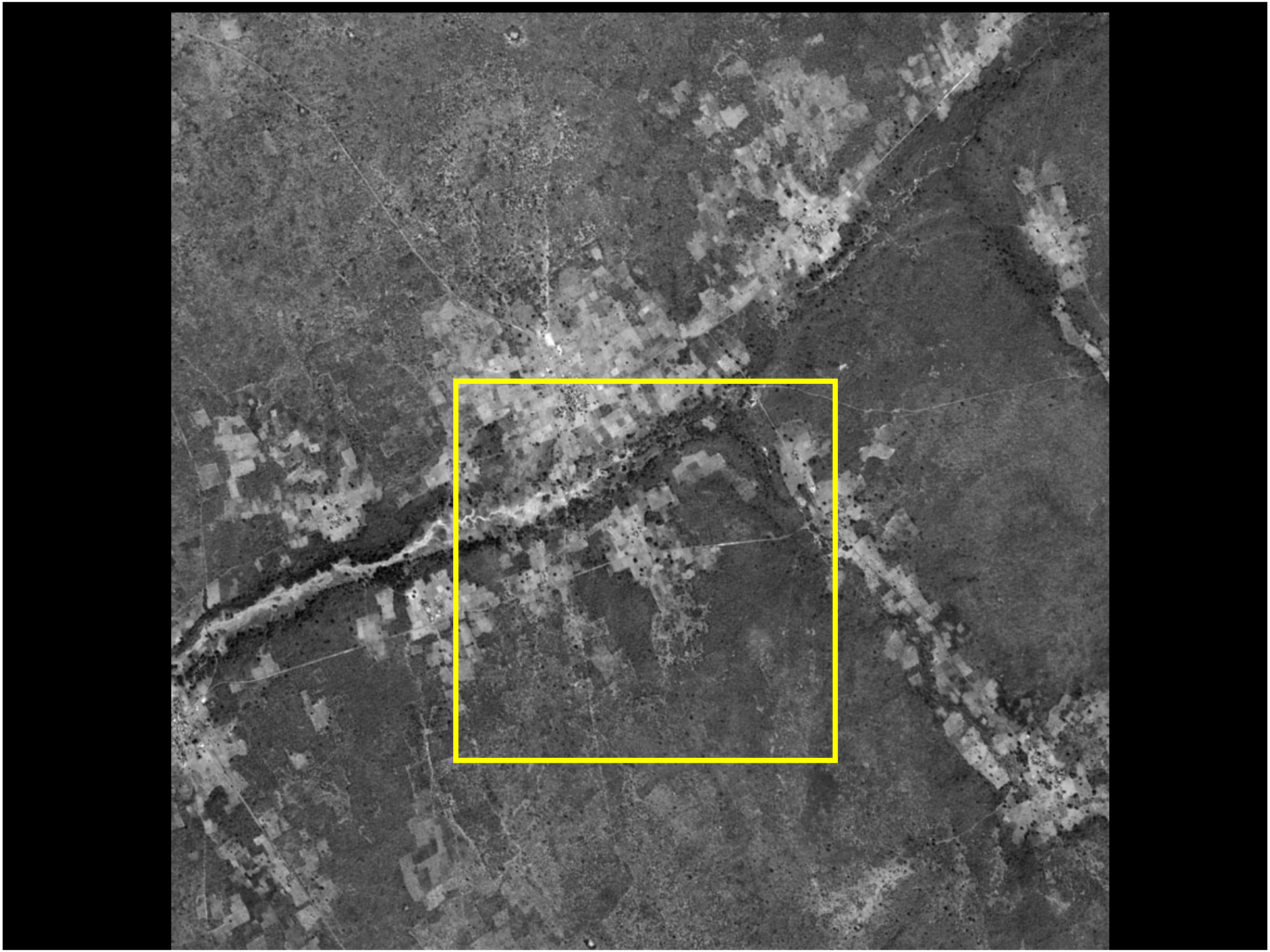
SPOT 5
4 January 2003

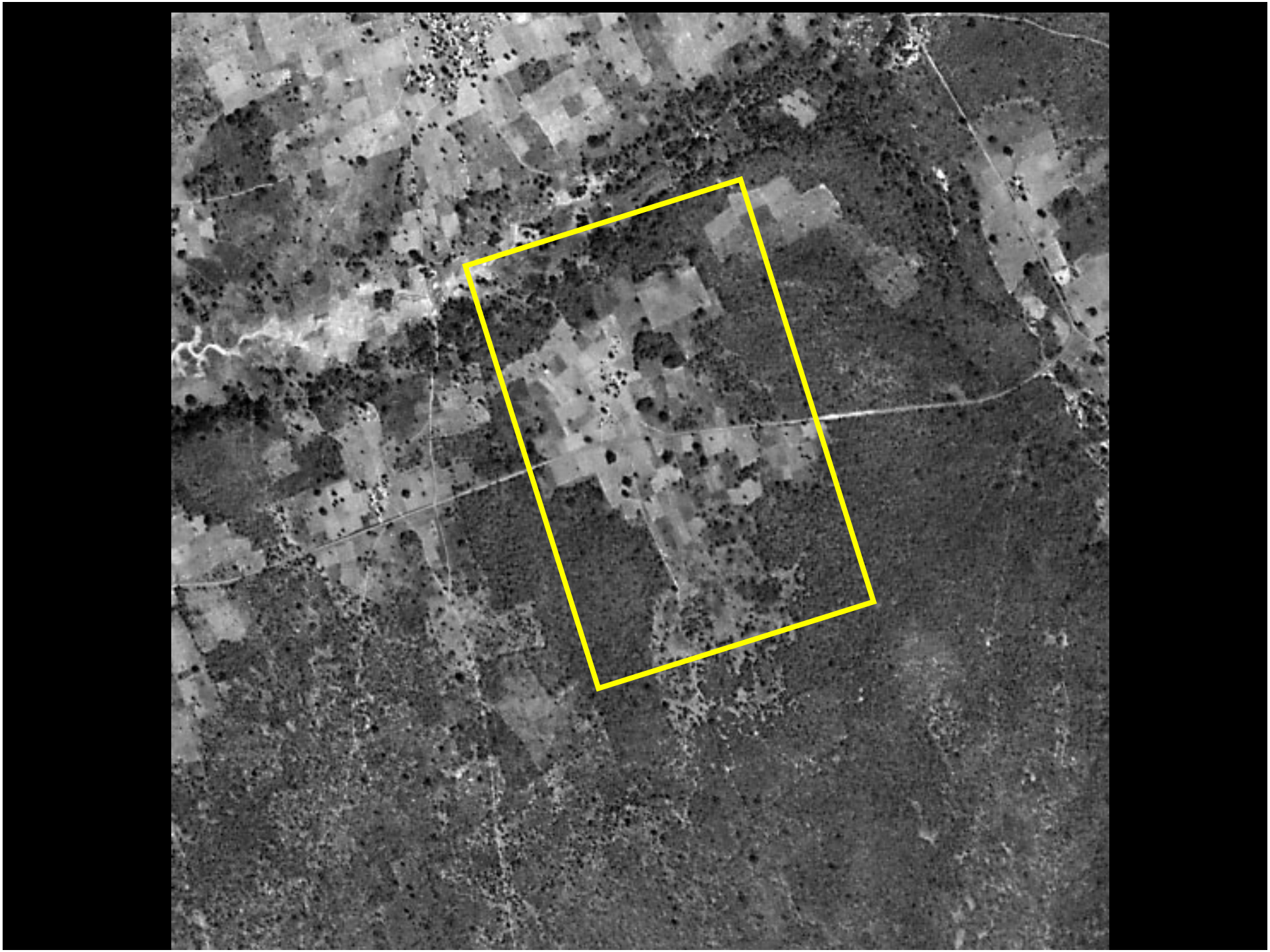
5m resolution







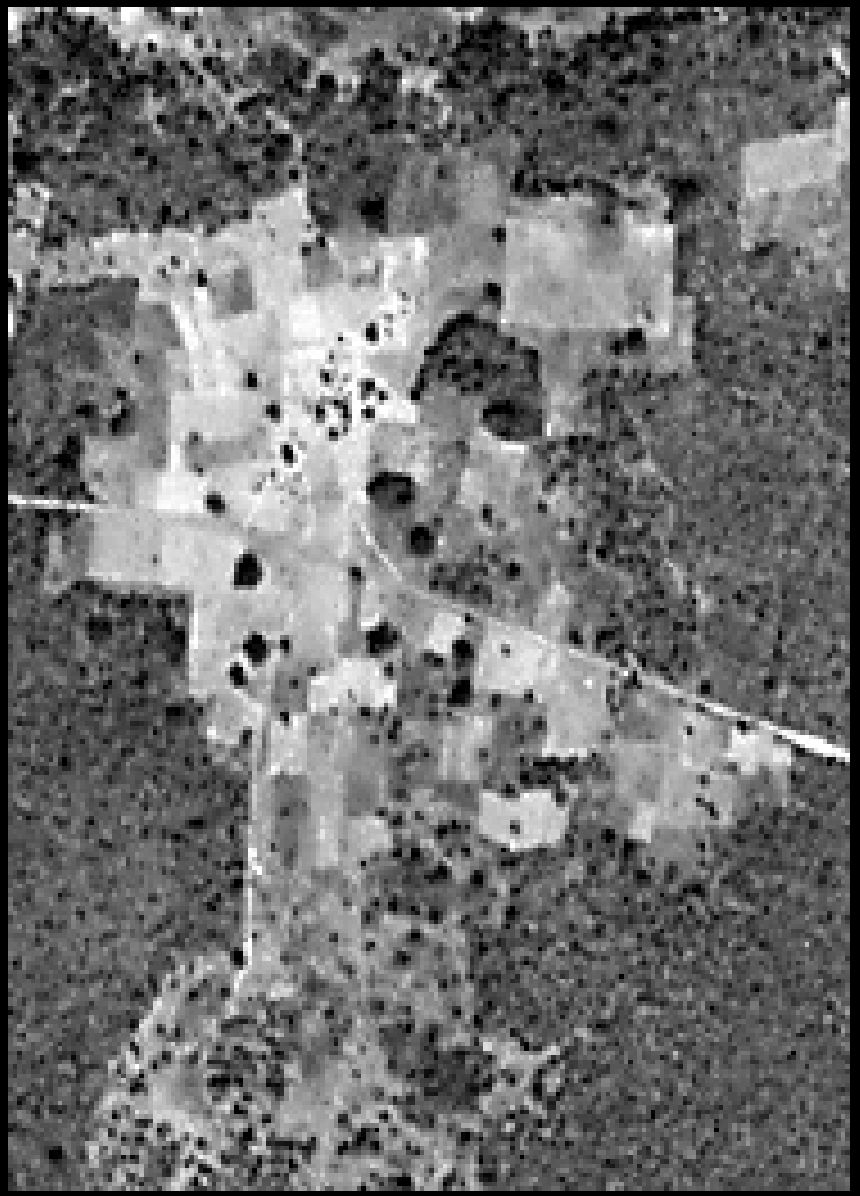




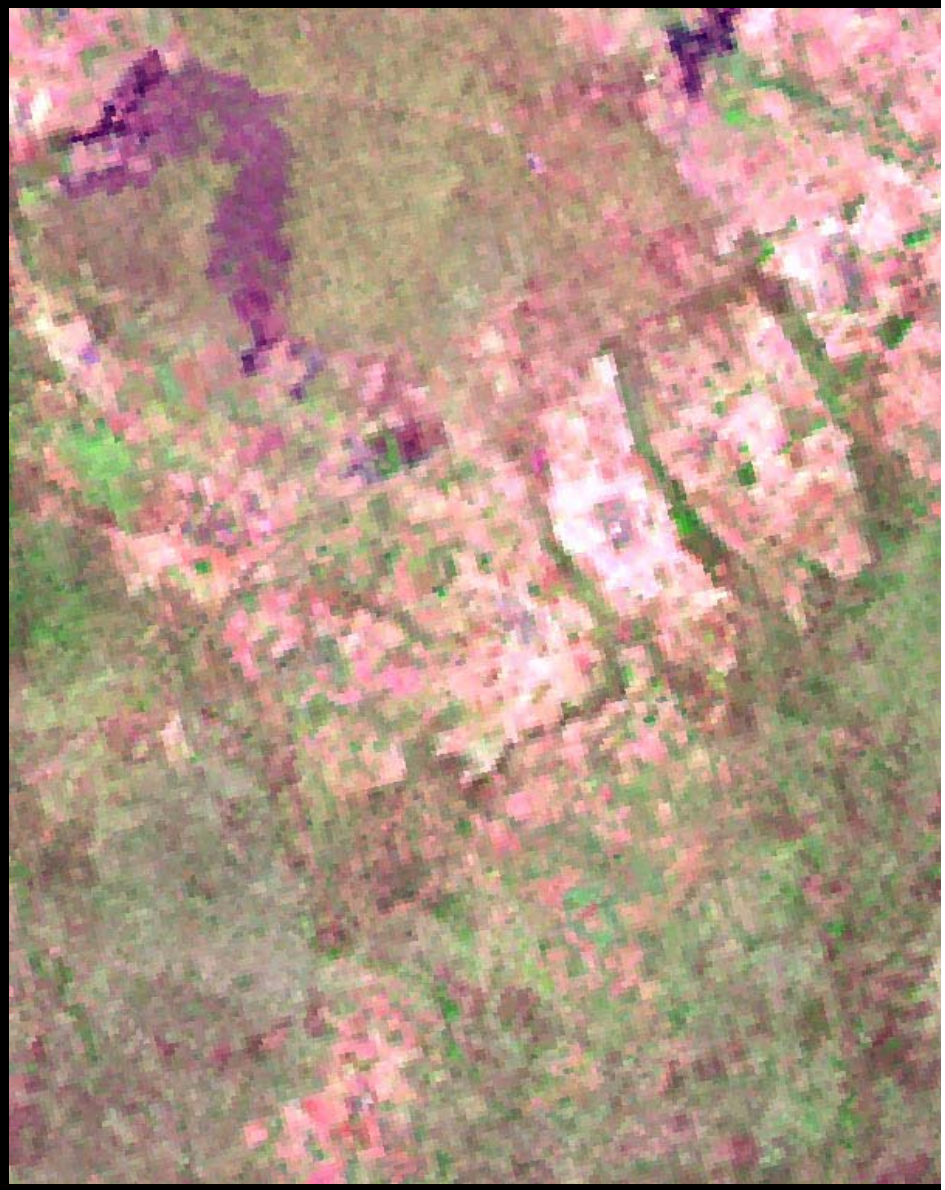
Aerial Photo of November 2003 Registered to SPOT Image of January 2003

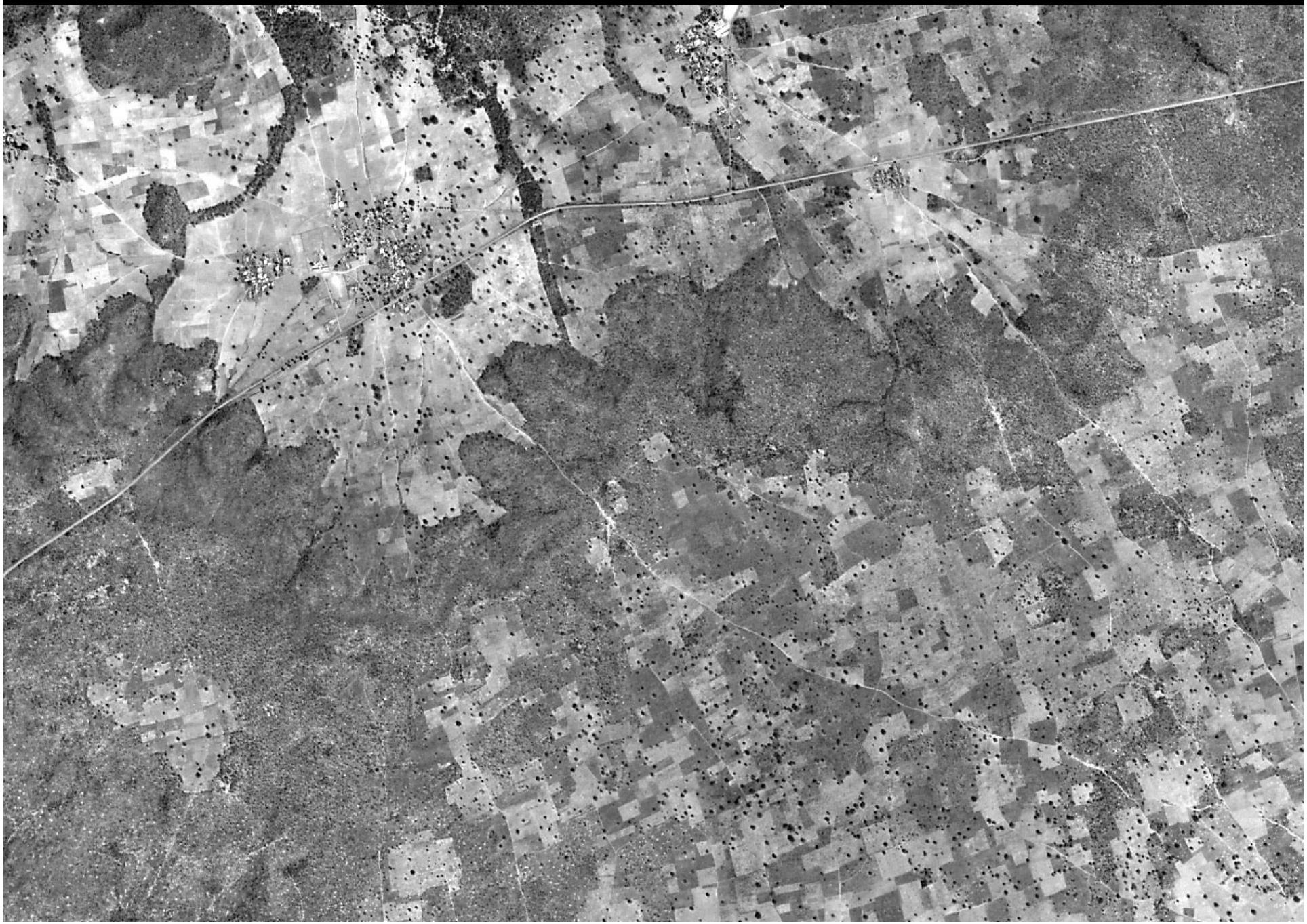
Aerial Photo of November 2003

Comparison of Aerial Photo to SPOT Image



Comparison of SPOT Image with Landsat ETM+ Image





Vous avez 3 secondes pour interpréter la photo suivante…

You have 3 seconds to interpret the following photo…

Vous avez 2 secondes pour interpréter la photo suivante…

You have 2 seconds to interpret the following photo…

Place

- Landscapes are shaped by the interaction between natural and anthropogenic agents:
  - Geology
  - Soils
  - Landforms
  - Climate
  - Population density
  - Land use practices
  - Social values

Place

- Features, patterns, colors in images are the result of the interaction of landscape forming agents - over time.
- Prior to interpreting an image, it is important to gain an understanding of the prevalent environmental and anthropogenic factors shaping the study area.

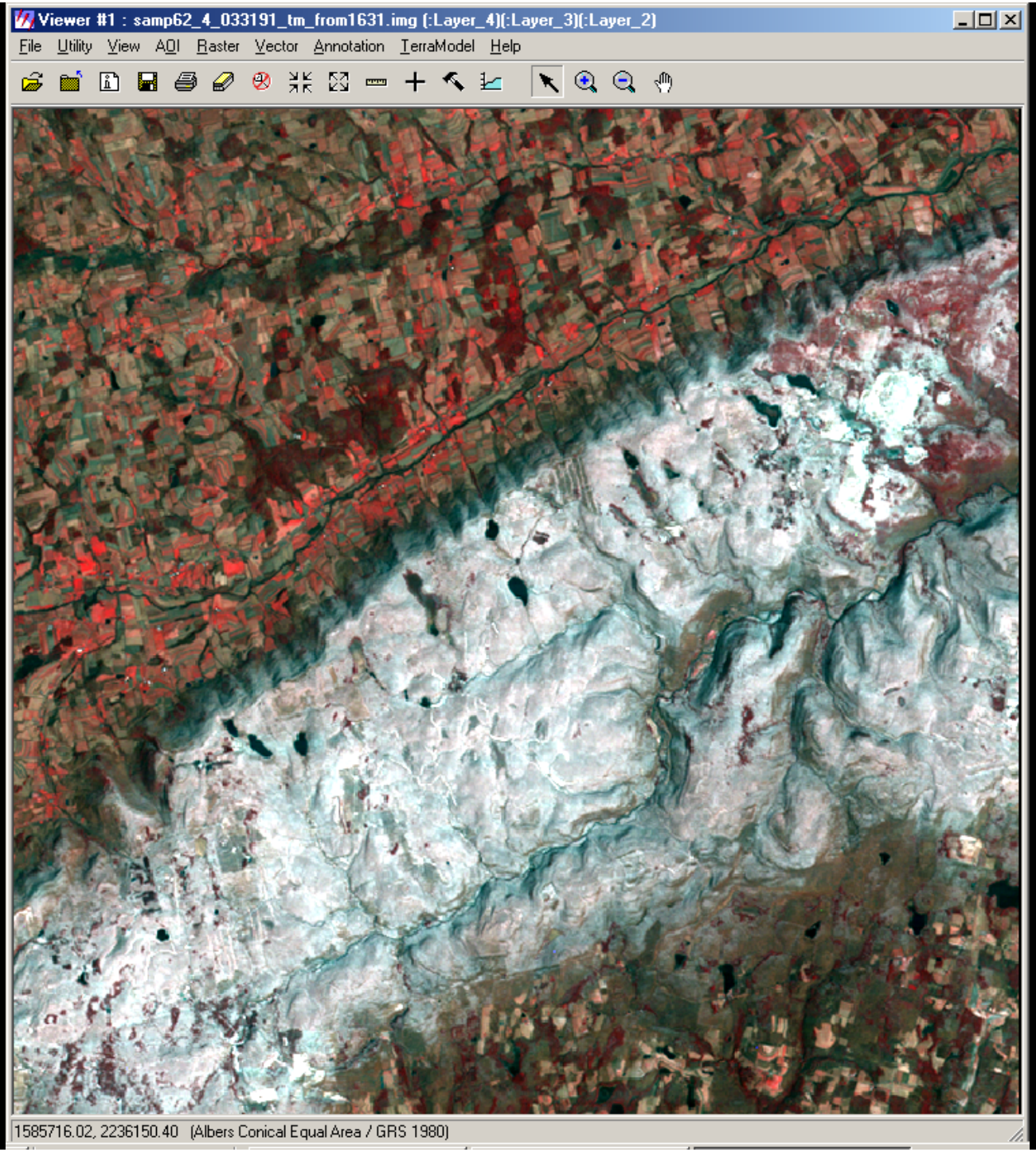
Place

- Useful references include:
  - Topographic maps
  - Soil surveys
  - Census of Agriculture statistics
  - Population census statistics
  - Contemporary weather and climate
  - Road maps

Time

- Time affects spectral characteristics
  - Time of day - illumination levels
  - Time of year - illumination levels, phenology
- Time affects the status of the landscape
  - Seasonal change - changes in the condition of the land cover
  - Year-to-year change - changes in the types of land cover

Le Volcan Mt. Saint Helens – Evolution diachronique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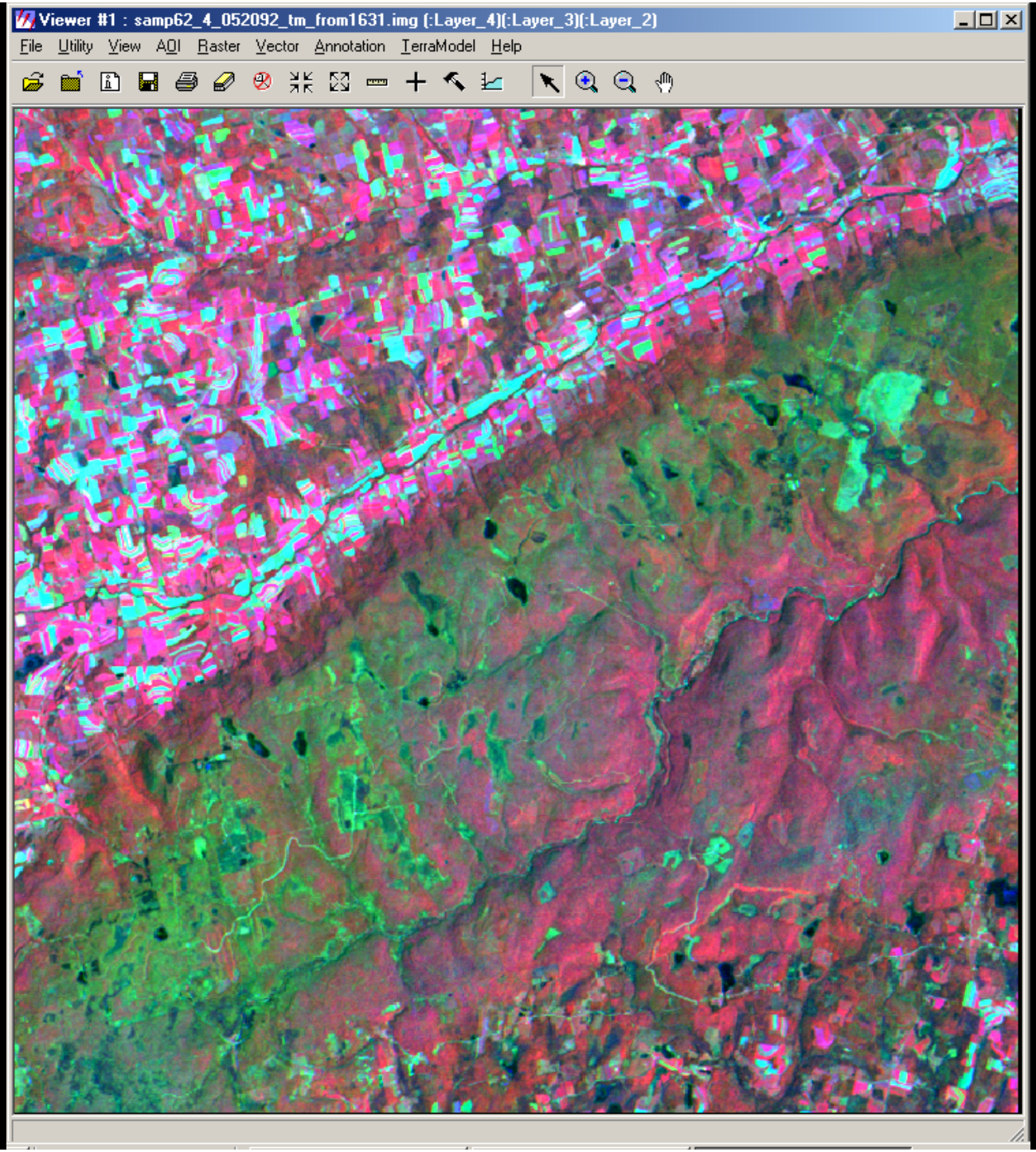
File Utility View AOI Raster Vector Annotation TerraModel Help
1585716.02, 2236150.40 (Albers Conical Equal Area / GRS 1980)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File Utility View AOI Raster Vector Annotation TerraModel Help

Photographies de la Terre par la navette : Les Montagnes de l’Atlas