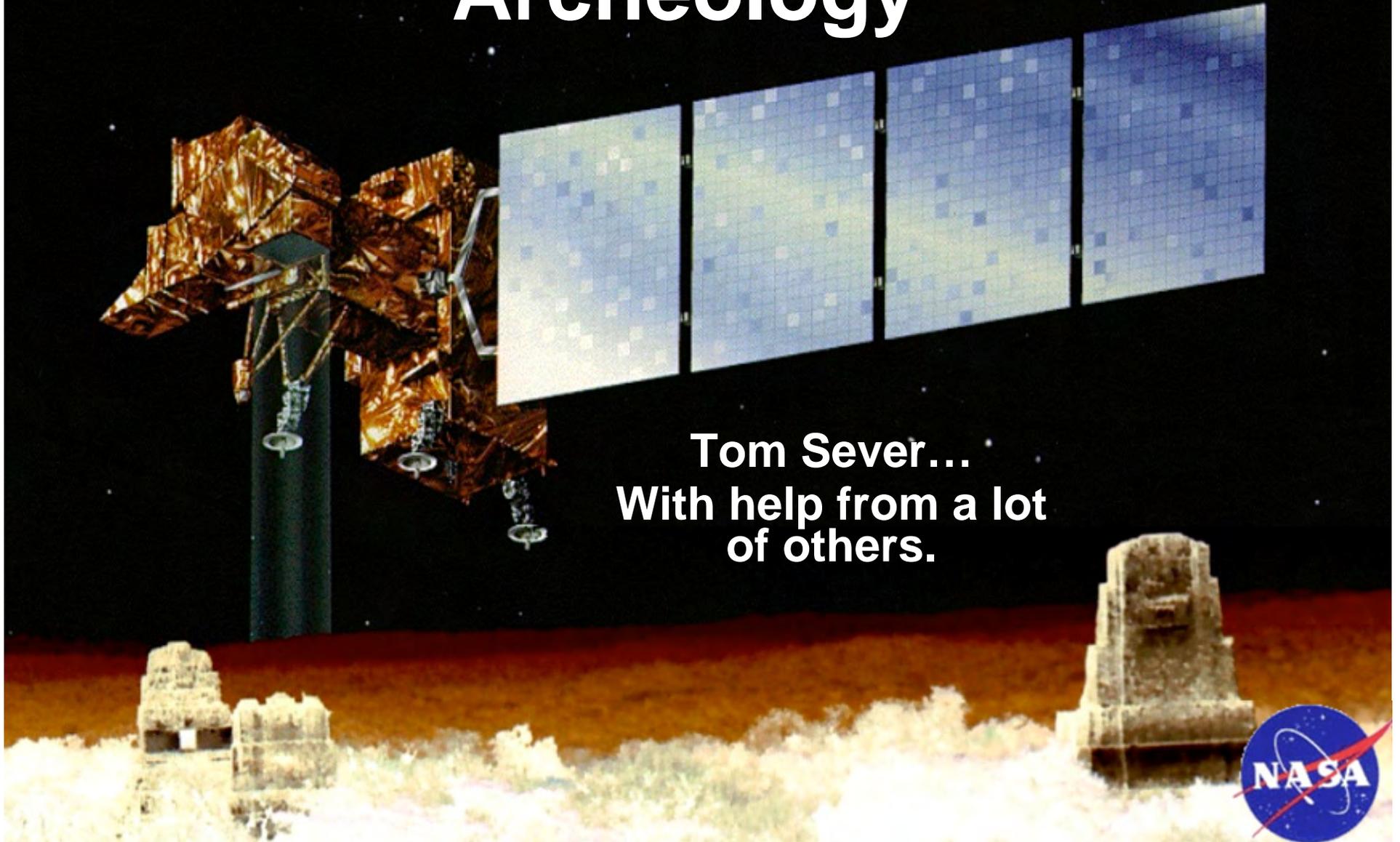


Abrupt Climate Change and Archeology

Tom Sever...
With help from a lot
of others.



“Plowed fields have replaced forests, domesticated animals have dispersed wildlife. Trees are plowed, mountains smoothed, and swamps drained. There are as many cities as in former years there were dwellings...Everywhere there are buildings, everywhere people, everywhere communities. Proof of this crowding is the density of human beings. We weigh upon the world; its resources hardly suffice to support us. As our needs grow larger, so do our protests that already nature does not sustain us.”

Tertullian 200 AD

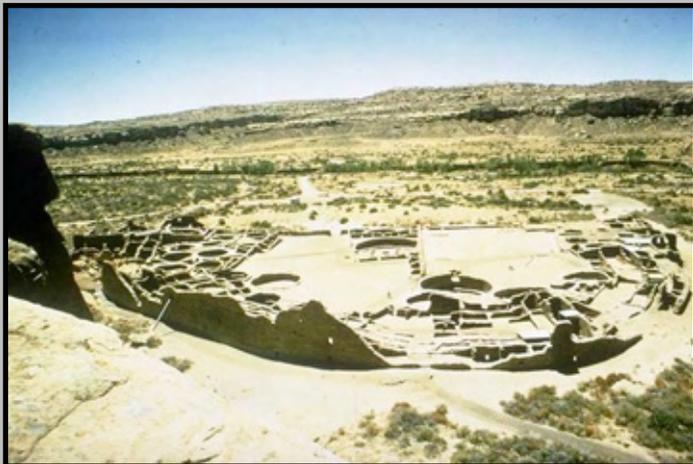
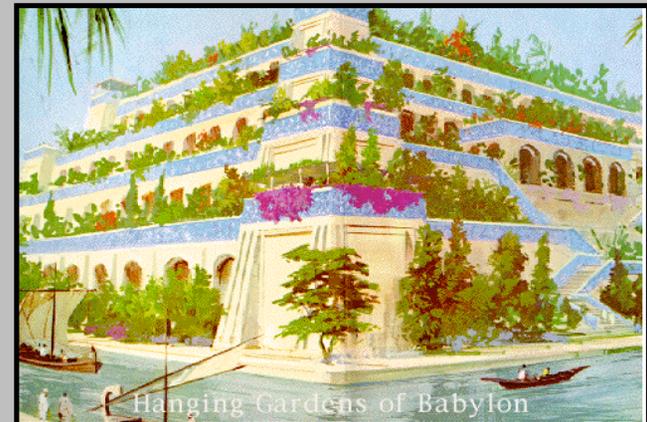
Carthage, North Africa



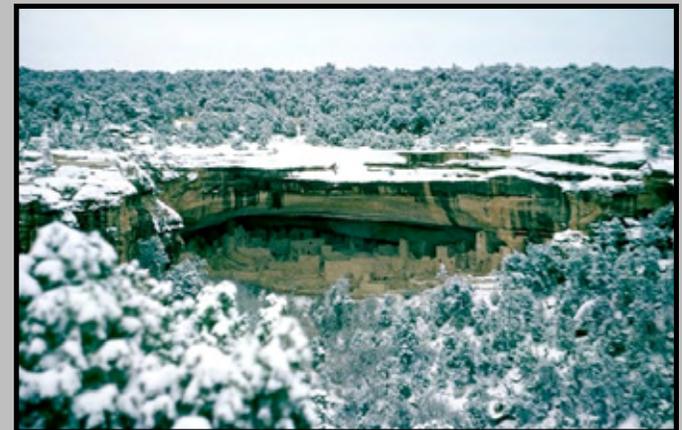
Easter Island



Mesopotamia



Anasazi





4200 ka BP Event (2200 BC)

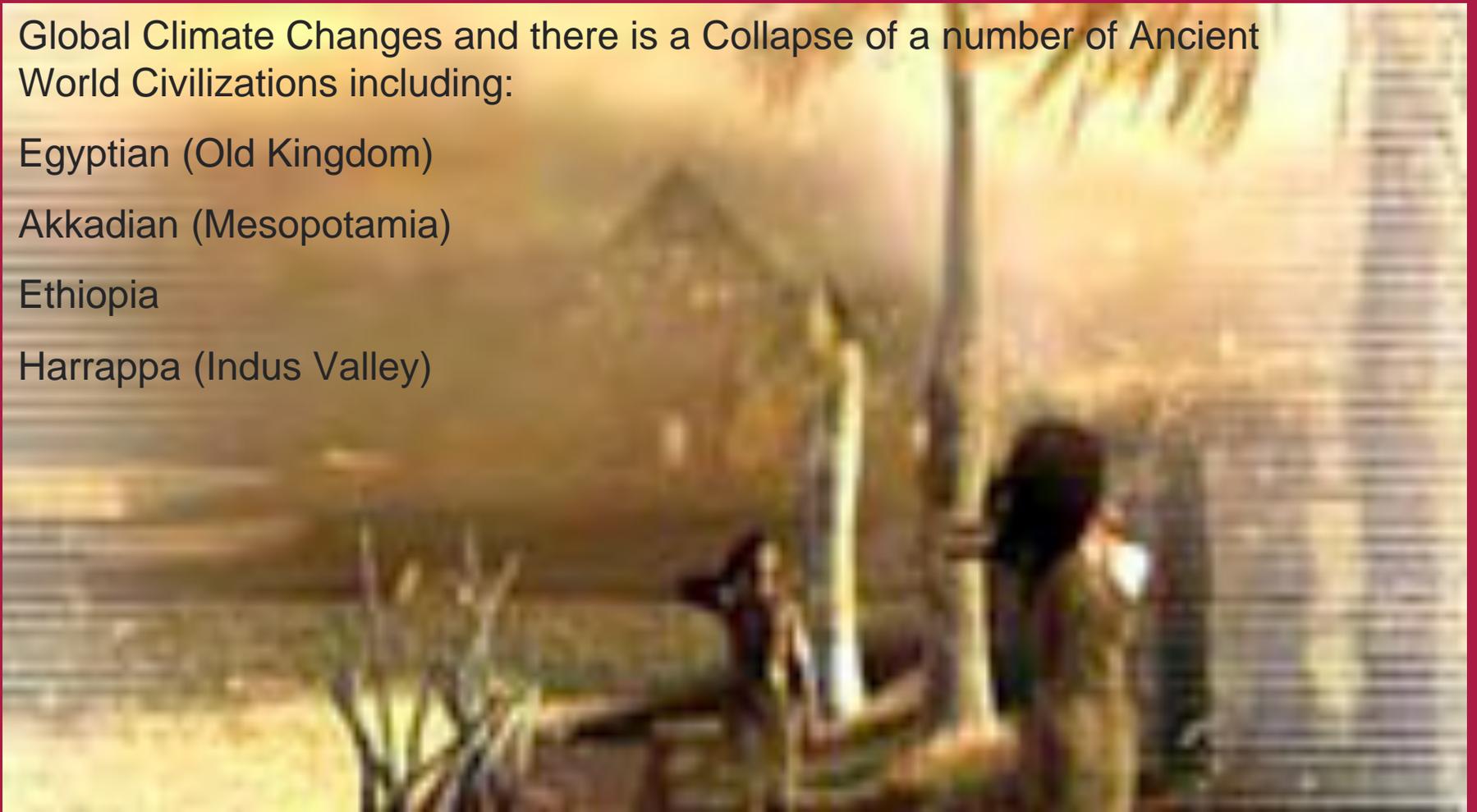
Global Climate Changes and there is a Collapse of a number of Ancient World Civilizations including:

Egyptian (Old Kingdom)

Akkadian (Mesopotamia)

Ethiopia

Harrappa (Indus Valley)



Old Kingdom 2686-2160BC



Sarah Parcak

First Intermediate Period 2160-2055BC



Sarah Parcak

FIRST INTERMEDIATE PERIOD STELAE (2160-2055 BC)

Anktifi of Mo'alla:

“All of Upper Egypt was dying of hunger and each individual had reached such a state of hunger that he ate his own children.”

Merer of Edfu:

“I buried the dead and I nourished the living, wherever I went in the drought that occurred.”

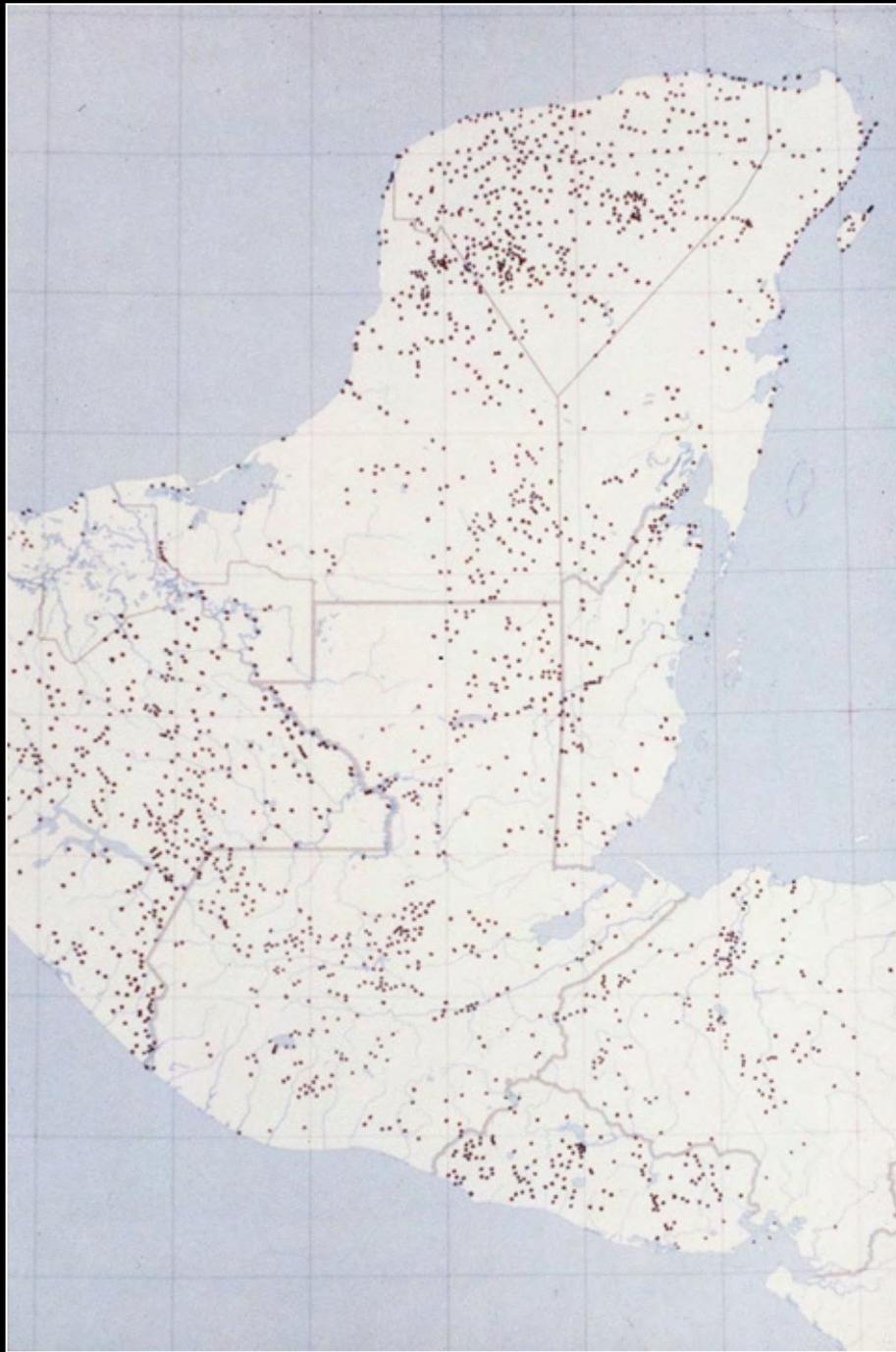
Prophecy of Neferti:

“Dry is the river of Egypt, one crossed the water on foot; one seeks water for ships to sail on, its course having turned into shore land.”

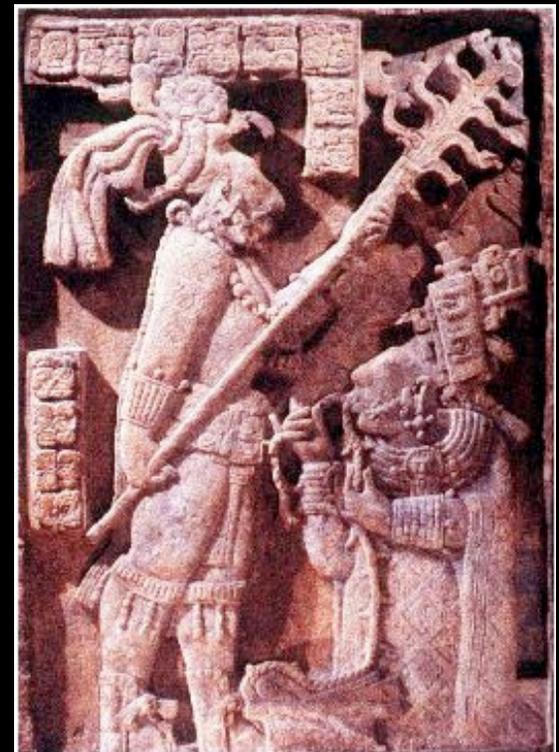
Nomarch Khety:

“I made a sluice-way for this town, while Upper Egypt was in a bad way, no water to be seen...every neighborhood thirsted.”

The entire Fayoum dried up—
this has not happened since.



Ancient Maya Cities



The Greatest Demographic Disaster in Human History

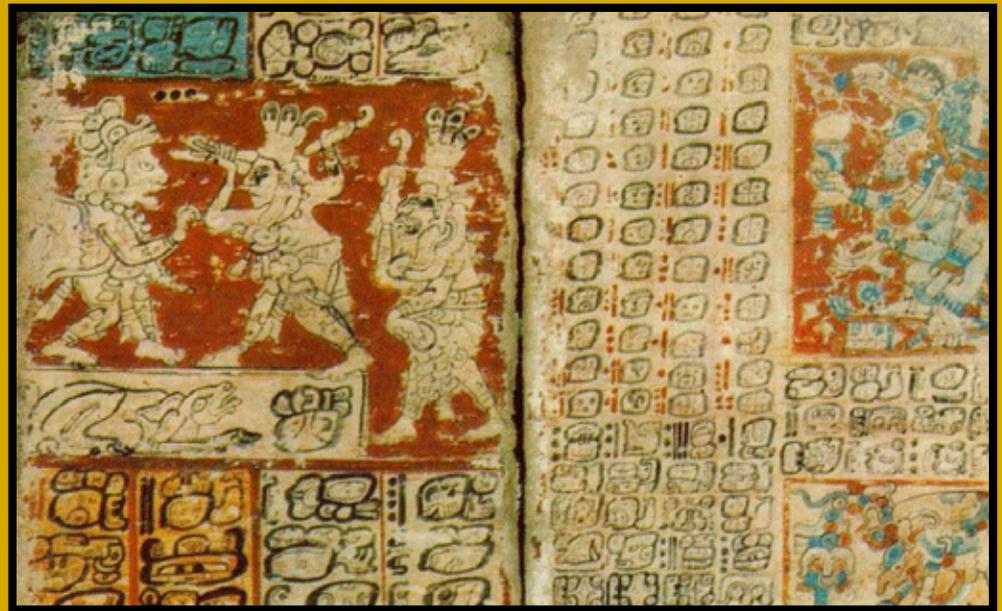
- Over 100 Explanations for the Maya Collapse including:
 - Hurricanes
 - Overpopulation
 - Disease
 - Deforestation/Soil Erosion
 - Peasant Revolt
 - Warfare
 - **Climate Change**

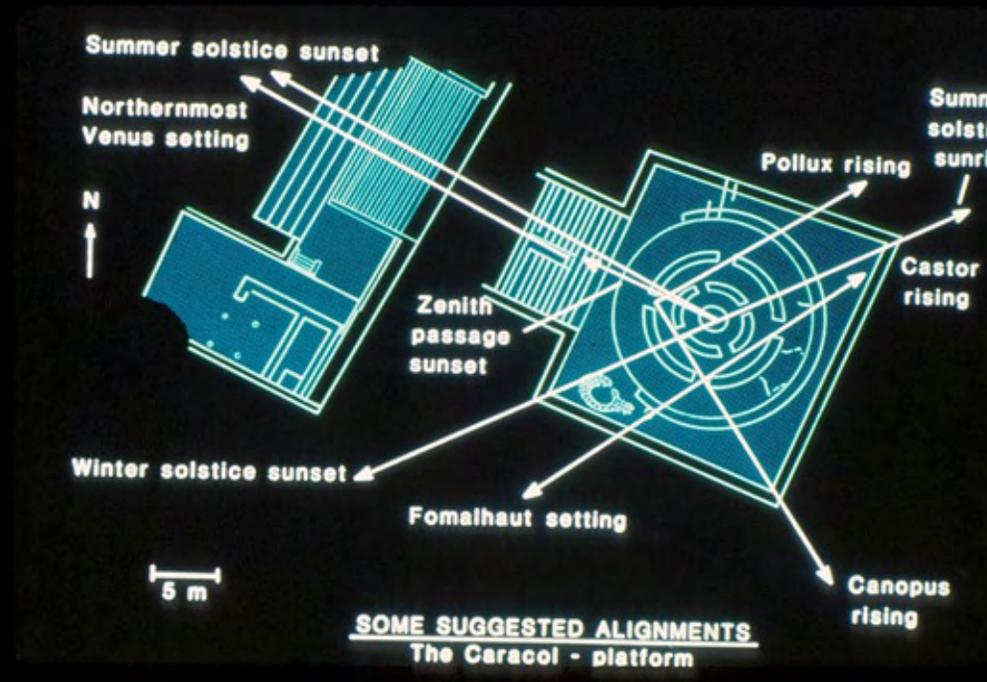




Fray Diego de Landa arrived in Mérida in 1549 to serve in a Franciscan monastery. Fanatical and ambitious, Landa later became Bishop of Yucatan, a position from which he set out to cleanse the practices of both Spaniards and Maya. In attempting to eradicate Maya "paganism," he burned countless "idols" and a number of ancient hieroglyphic books.

Surviving Books: Dresden Codex Madrid Codex Paris Codex Grolier Codex

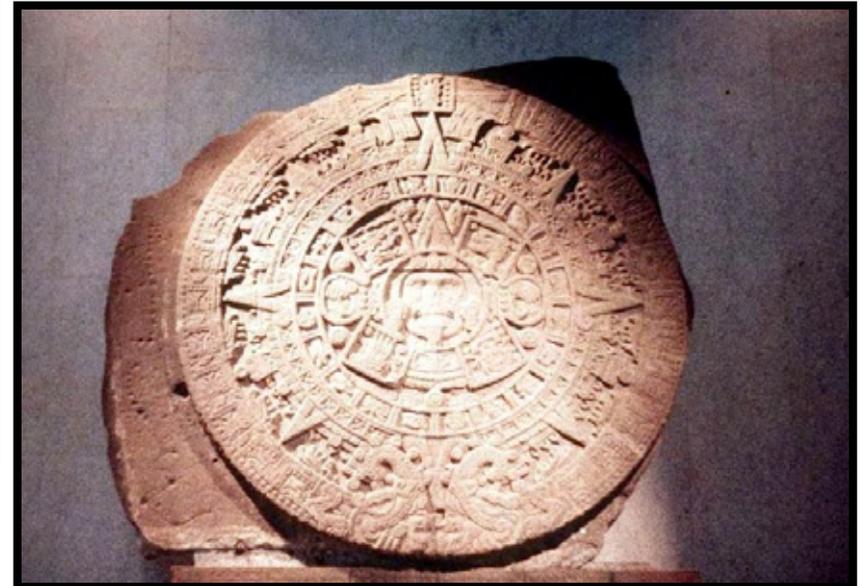


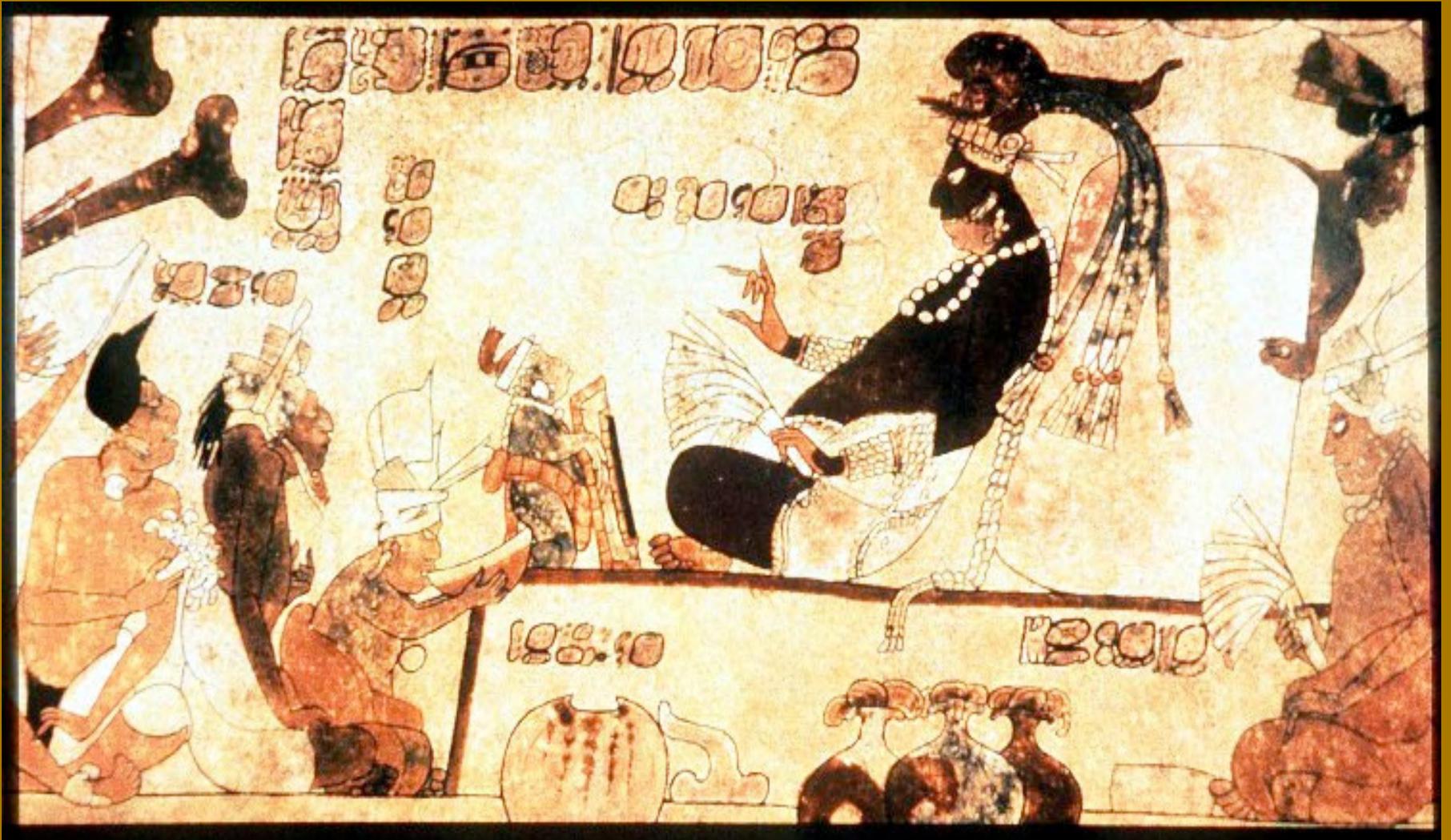


Maya Calendar

13 Numbers, 20 Days =
260-day Calendar

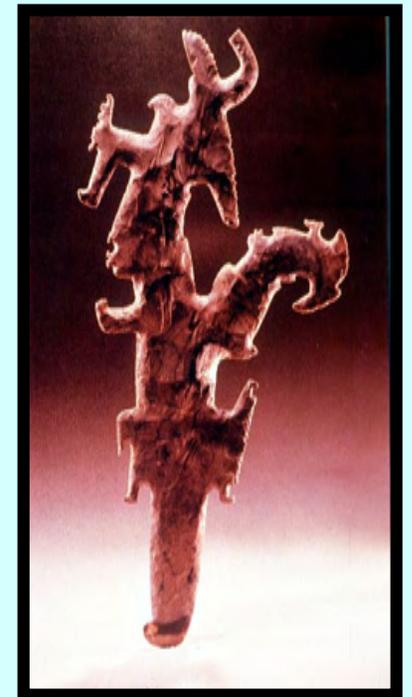
20 Months of 18 Days +
1 Month of 5 Days =
365 Day Calendar





Motul de San Jose

Tikal, Guatemala



Ah Bolon Tun

Ceibal

849 AD



El Mirador

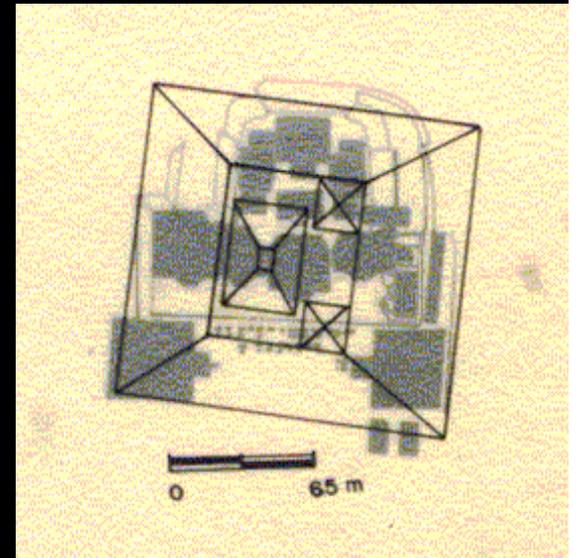


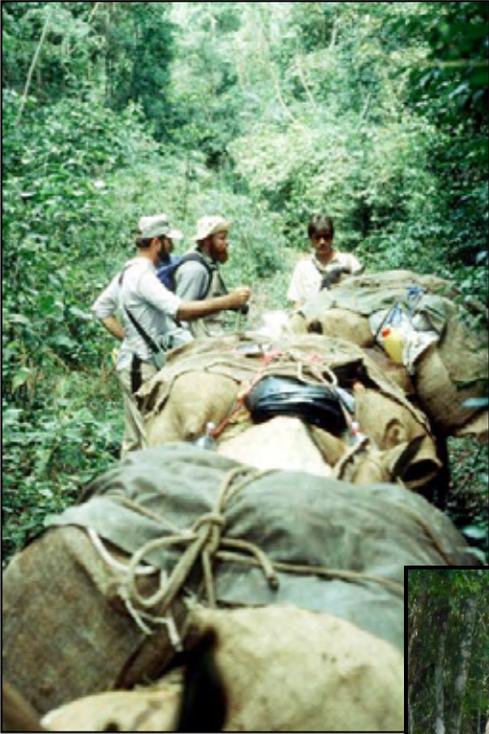


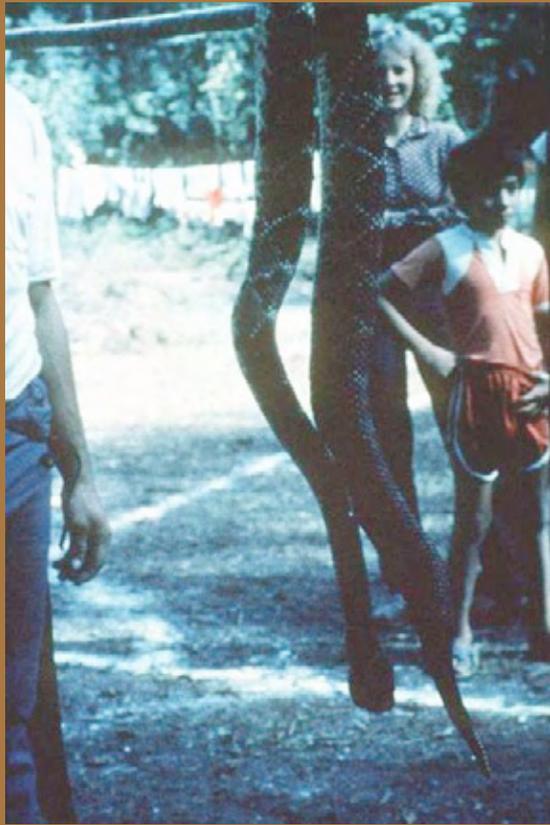


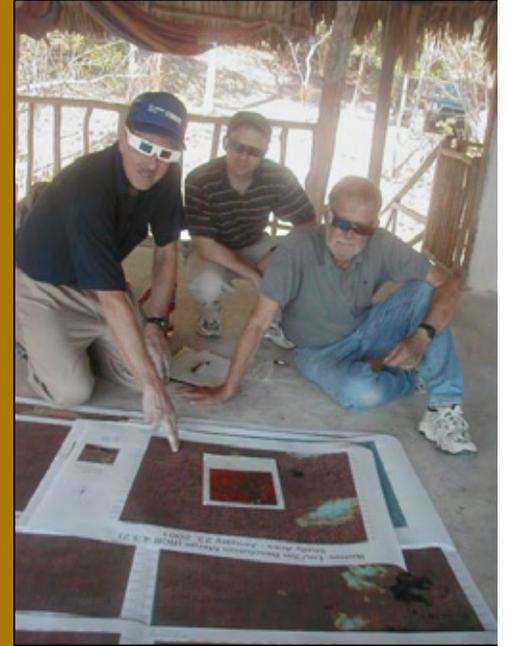


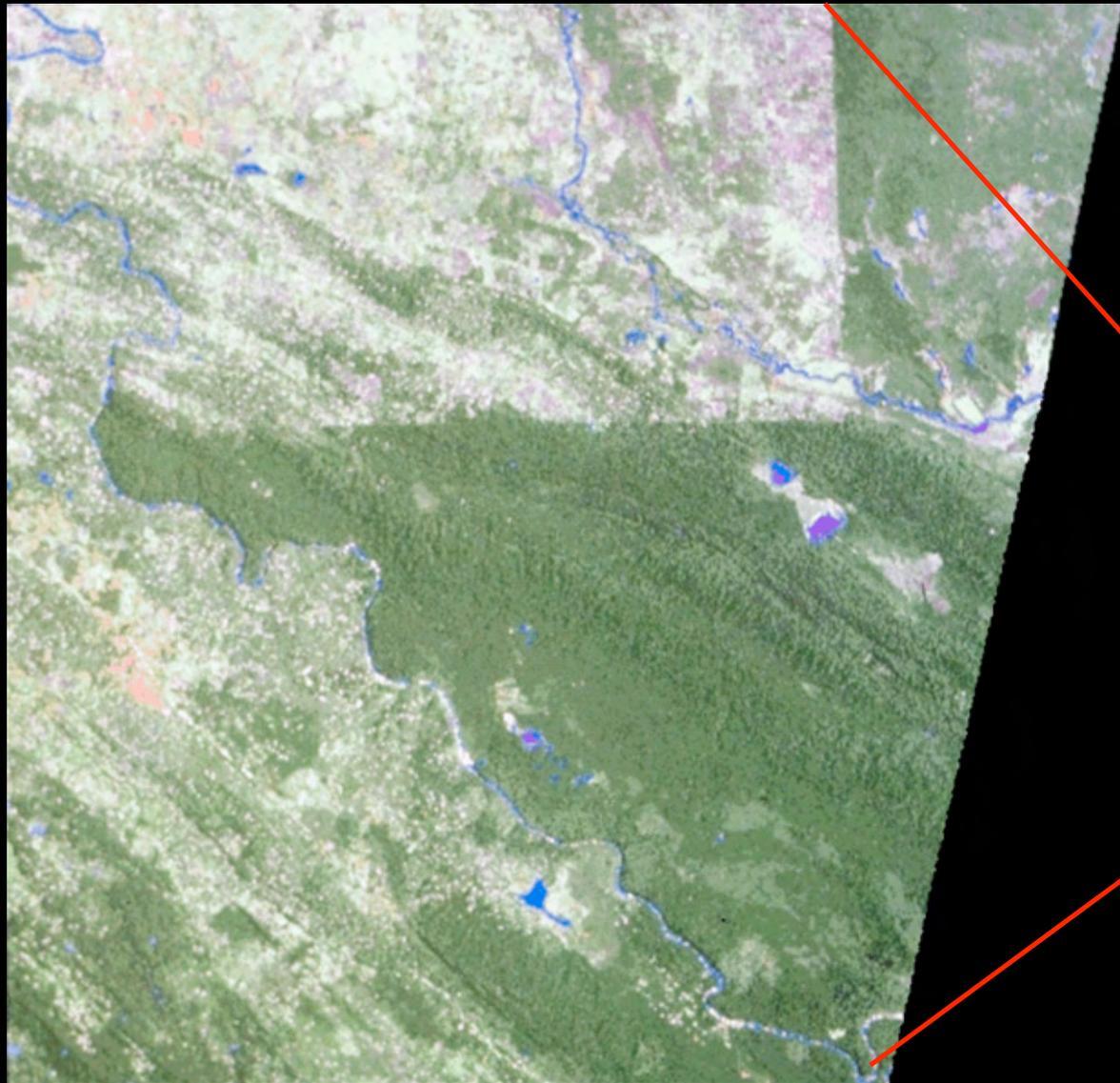






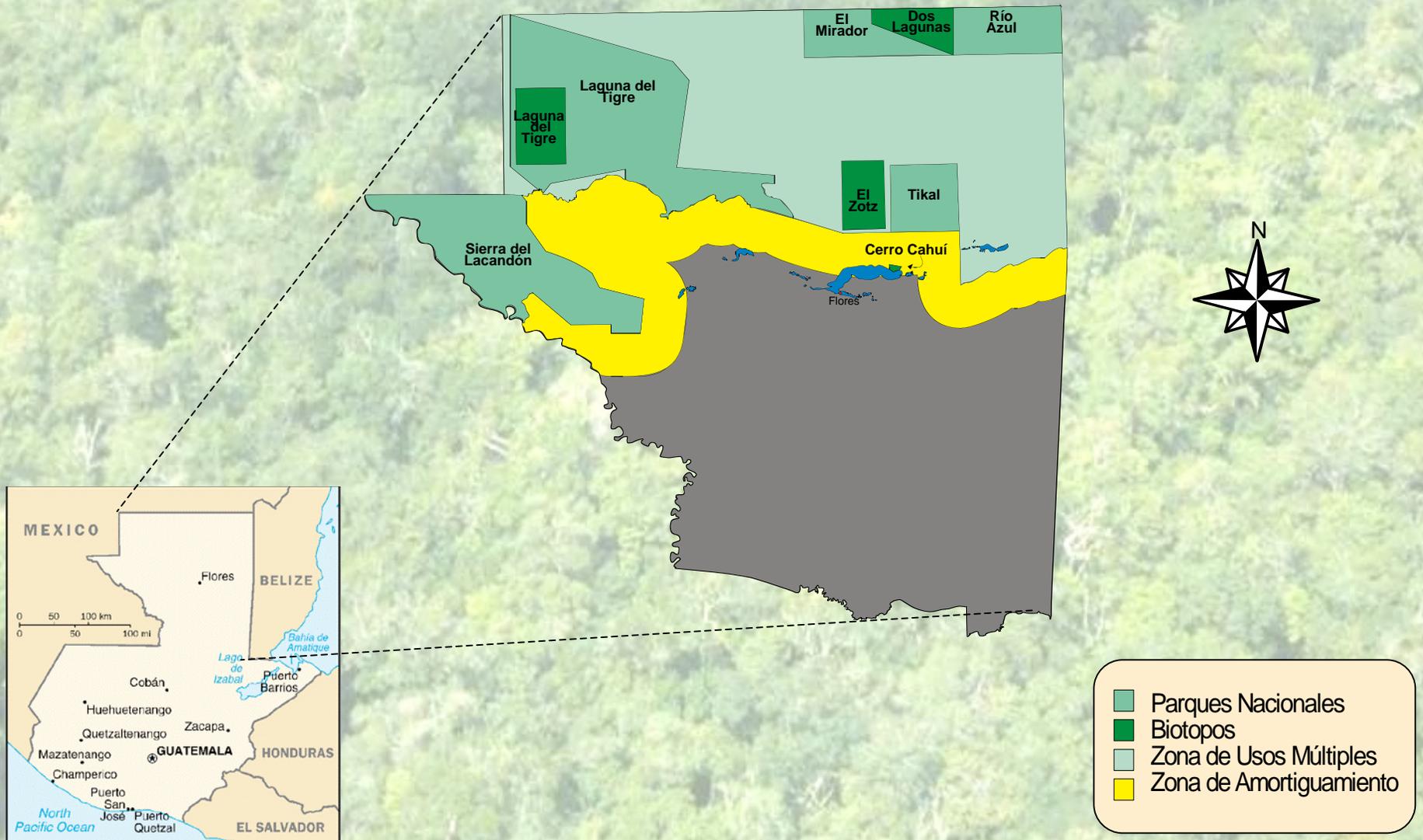








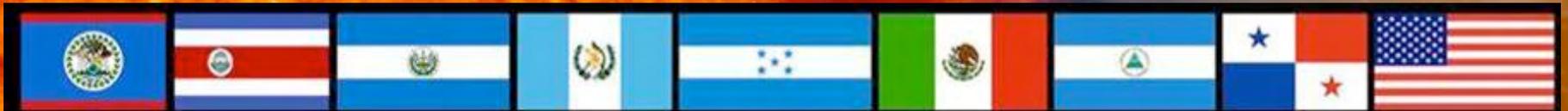
The Maya Biosphere Reserve, Peten, Guatemala



Utilizing the Unique
View from Space

NASA

SERVIR: An
Environmental
Monitoring and
Decision Support
System for
Mesoamerica





SERVIR Lab in Panama - CATHALAC



Decision Support

SERVIR - Microsoft Internet Explorer

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Address <http://servir.nsstc.nasa.gov/> Go Links

SERVIR

The Mesoamerican Regional Visualization and Monitoring

WED, JULY 26, 2006

● Español
● English

[SERVIR Data](#) | [Online Maps](#) | [GEOSS Decision Support](#) | 3

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Your "One Stop Shop" for Decision Support, and Information

Mesoamerica Today, July 26, 2006

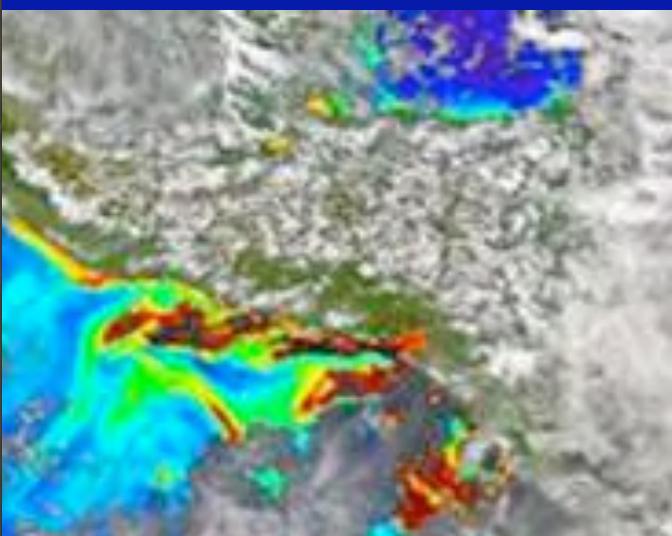
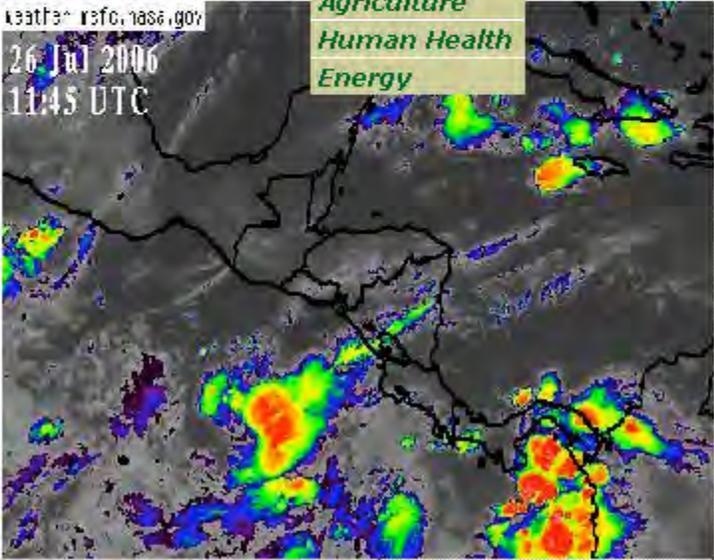
Go to SERVIR Realtime Information
Latest GOES image
weather.refc.nasa.gov

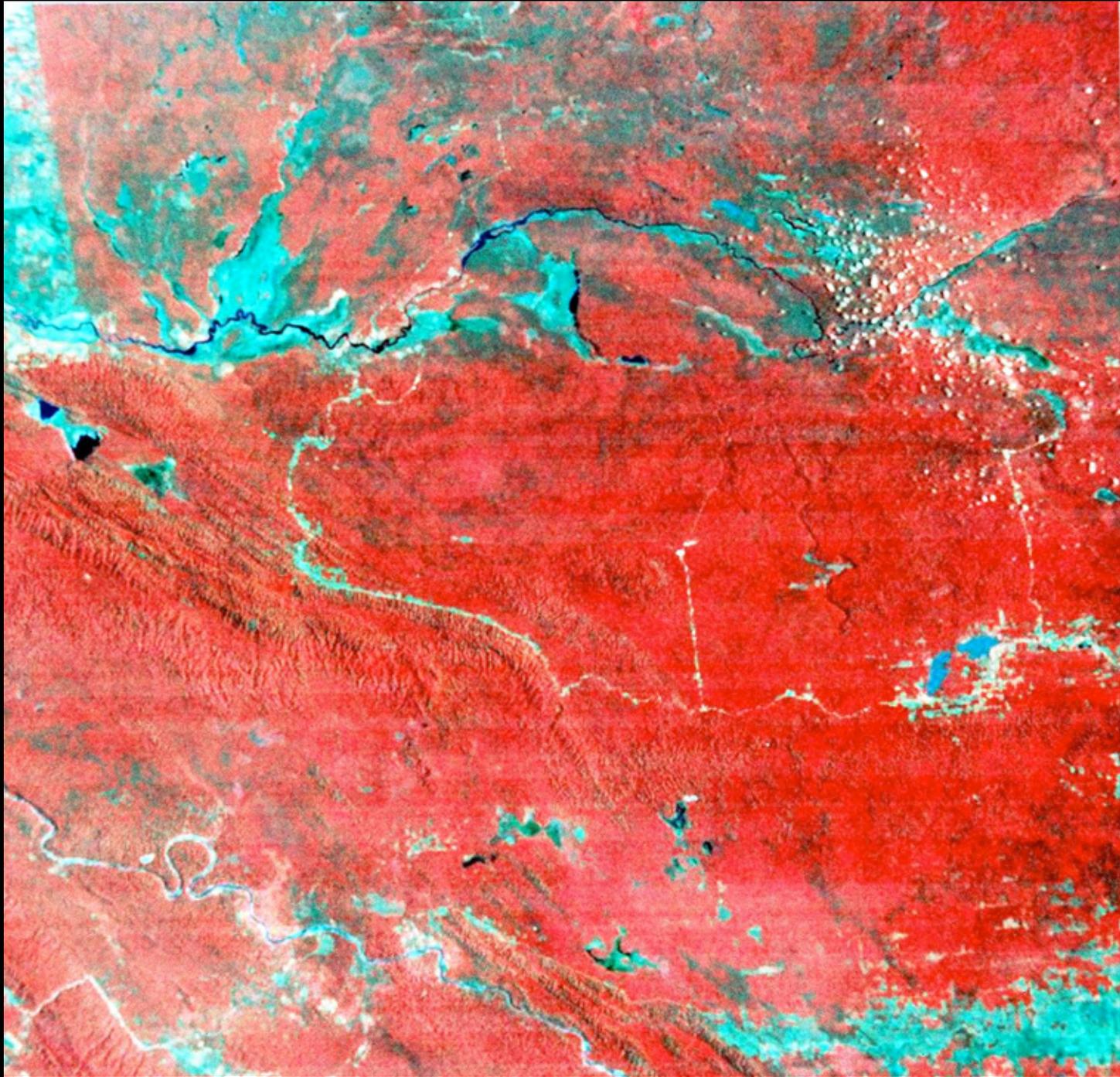
26 Jul 2006
11:45 UTC

- Disaster
- Ecology
- Weather
- Climate
- Oceans
- Water
- Agriculture
- Human Health
- Energy

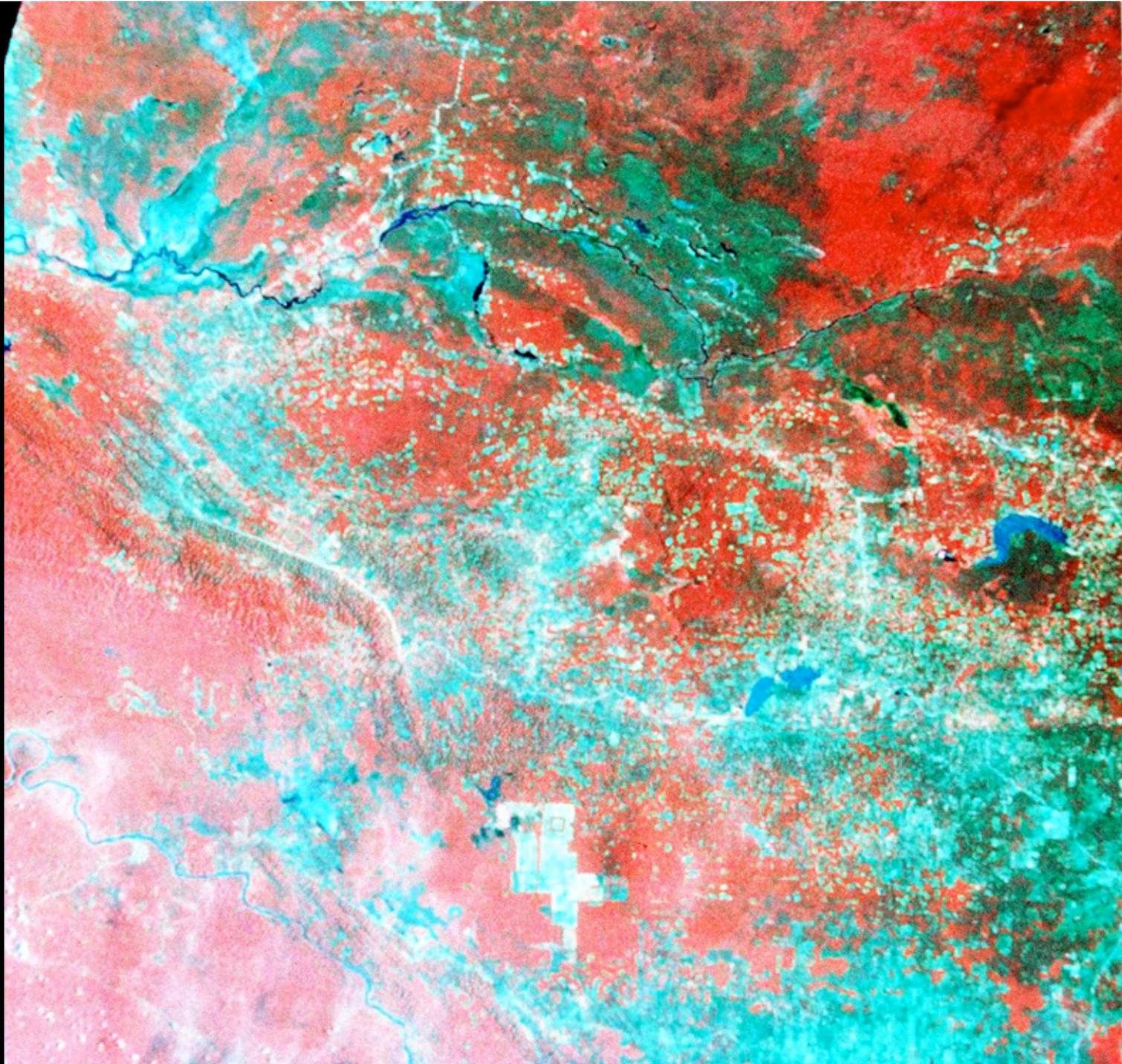
GEOSS Decision Support

Dynamic Map Visualizations

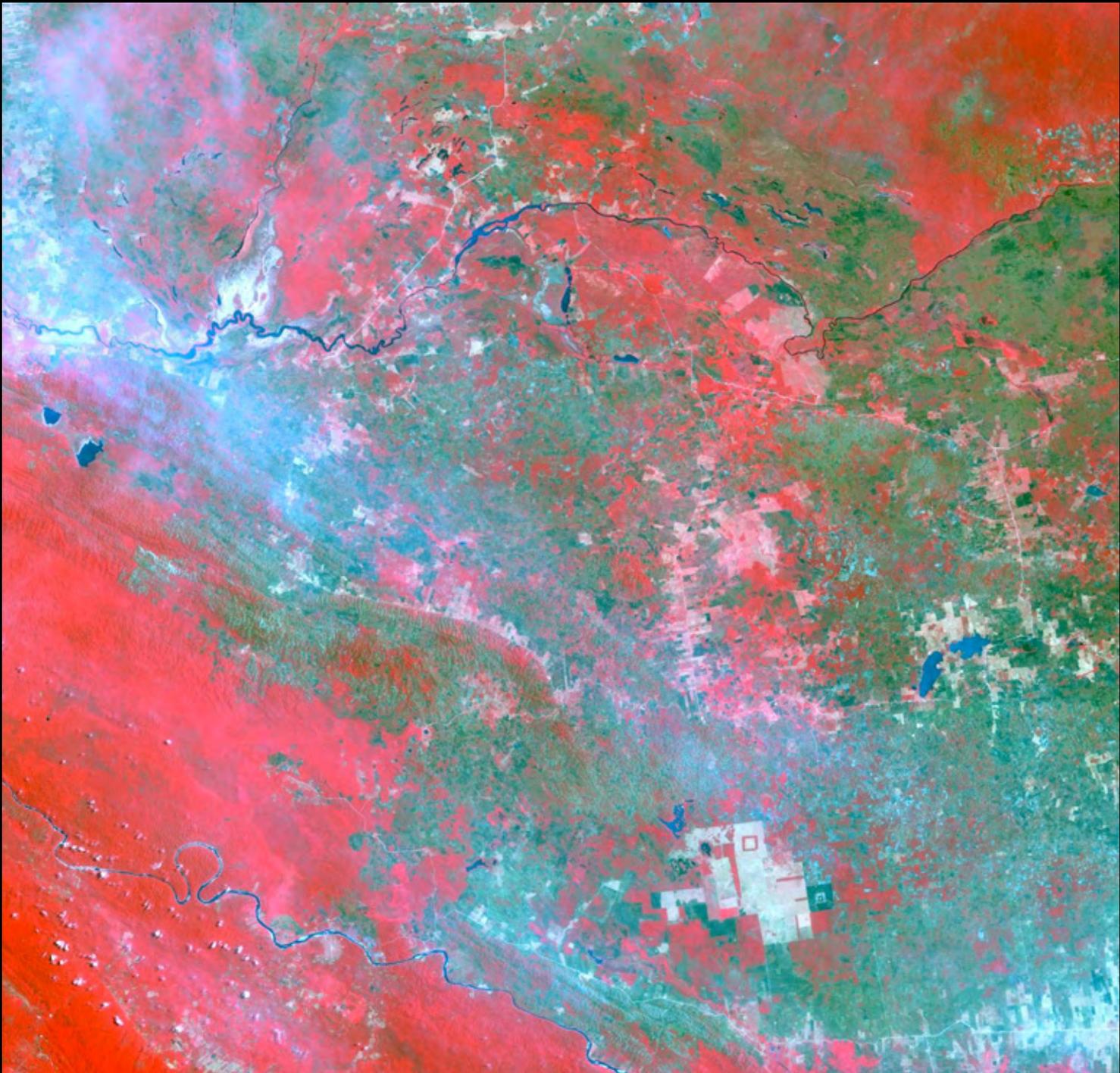




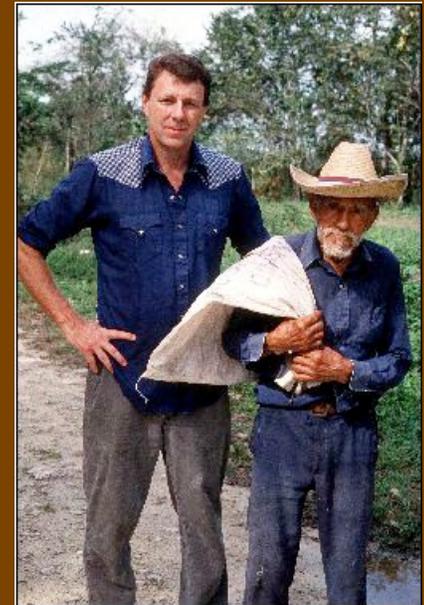
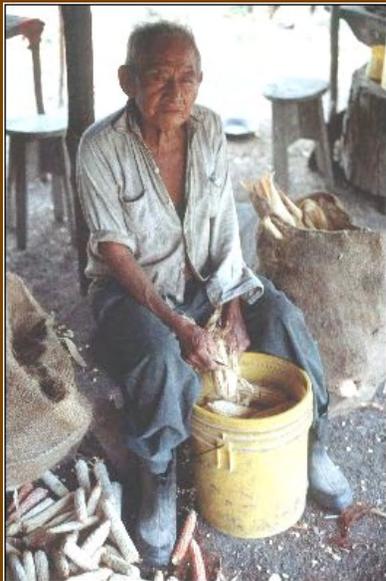
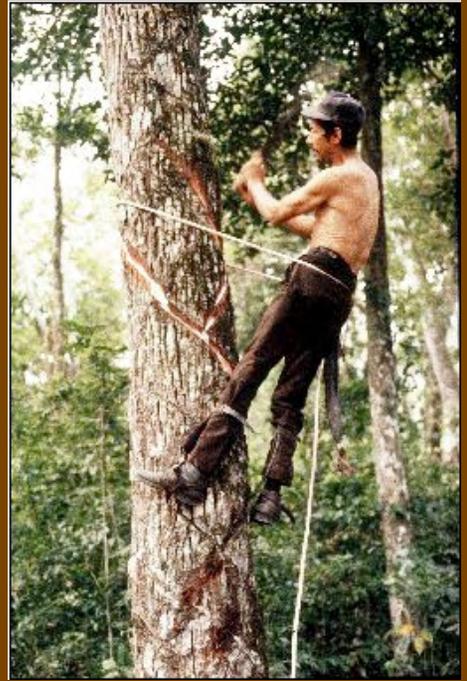
1986

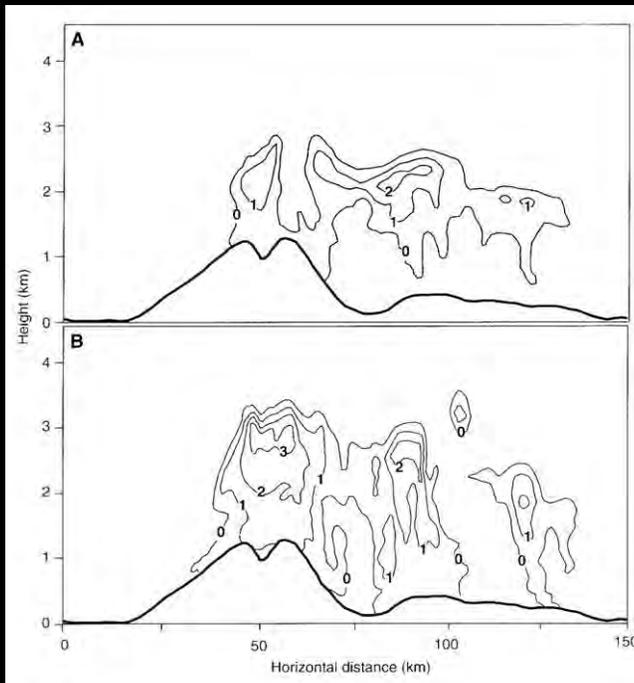
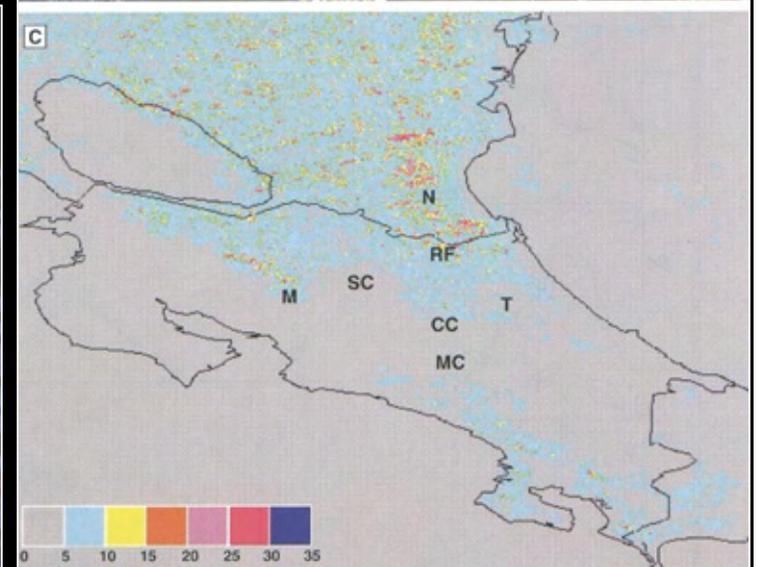
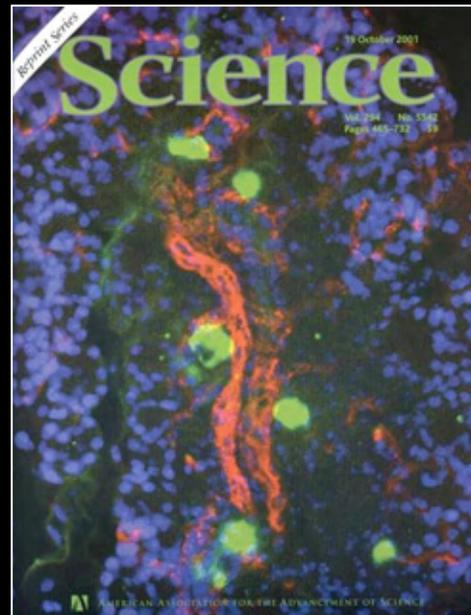
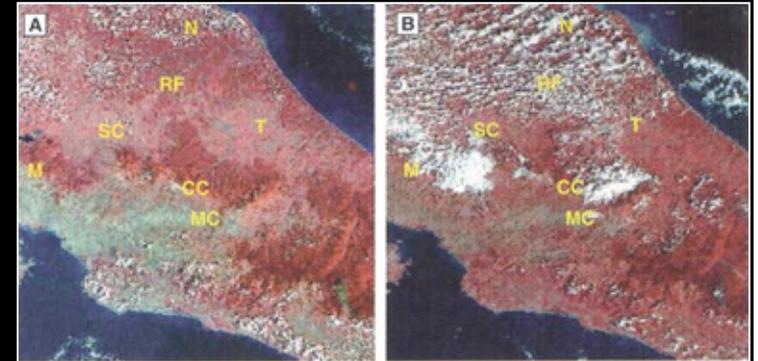
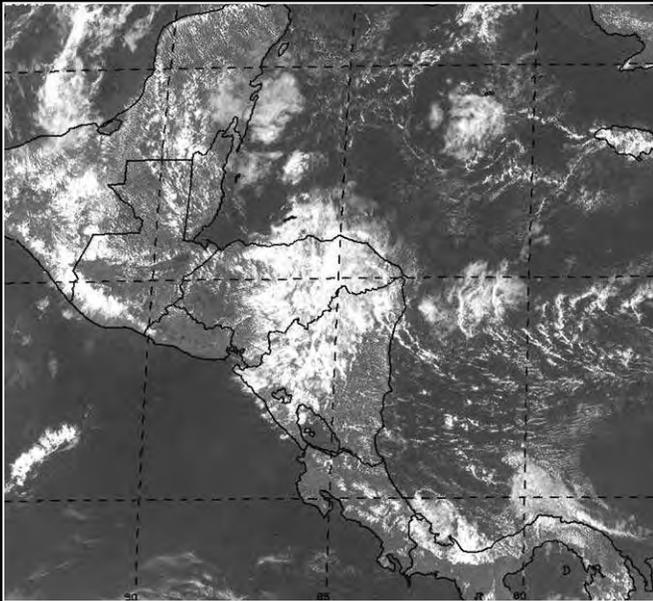


1995



2003

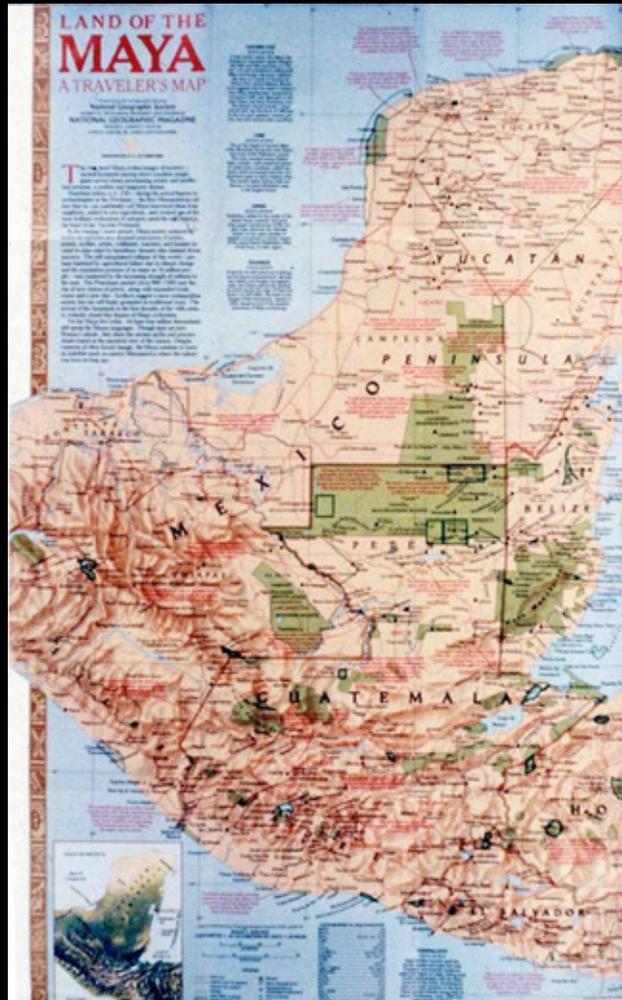




Climatic Impact of Tropical Lowland Deforestation on Nearby Montane Cloud Forests

R.O. Lawton, U.S. Nair, R.A. Pielke Sr., R.M. Welch

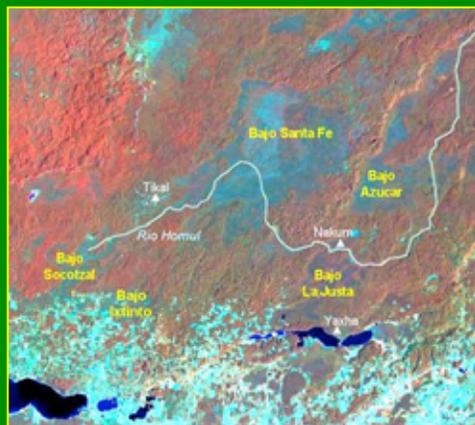
For hundreds of years the Maya depended on the predictable rain cycle.



When they filled all of their reservoirs they had an 18-month supply of water.



Rio Holmul



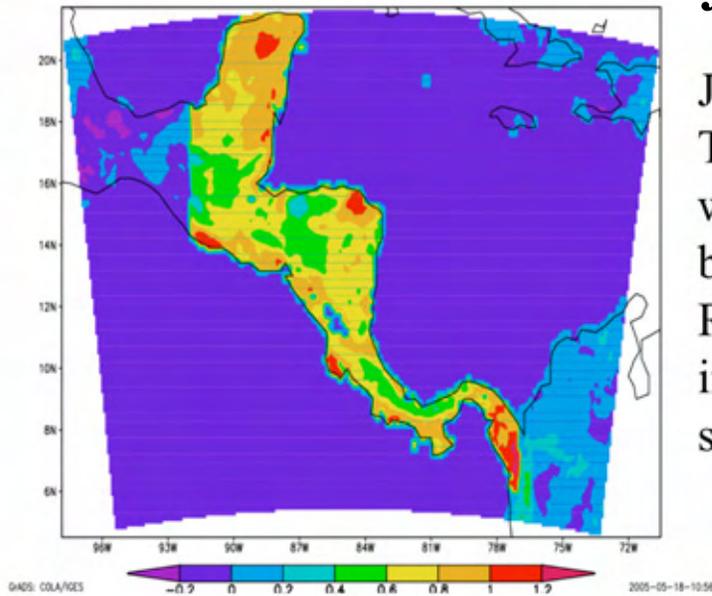


Karlen

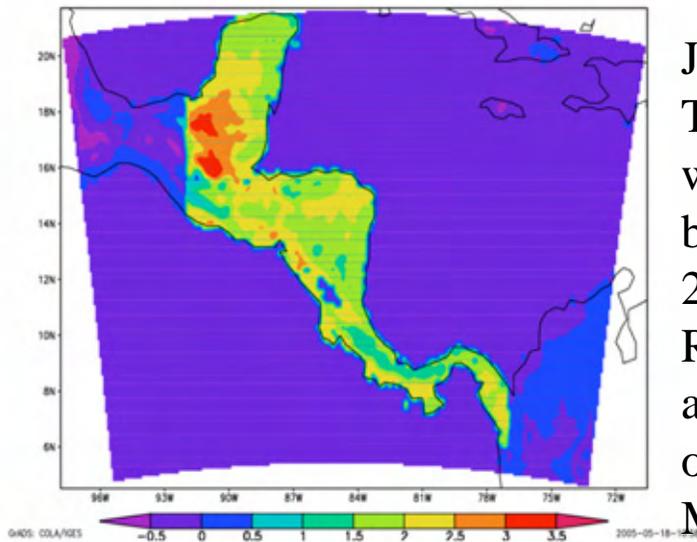
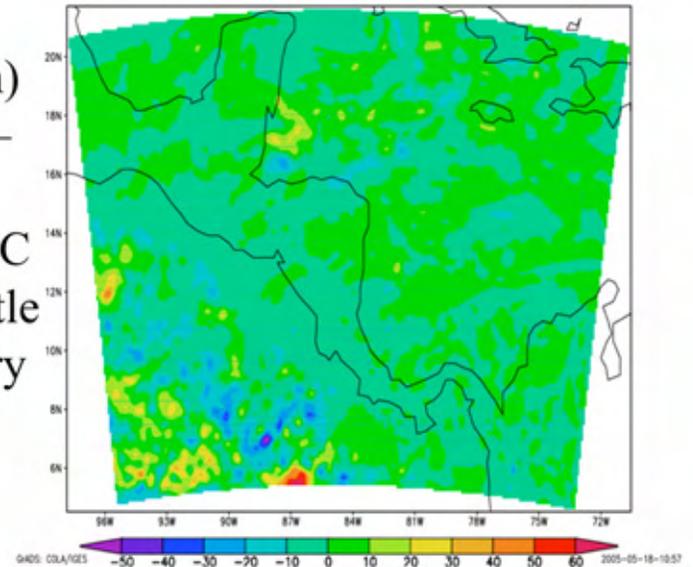
Hodell, Curtis, and Brenner

Peterson and Haug

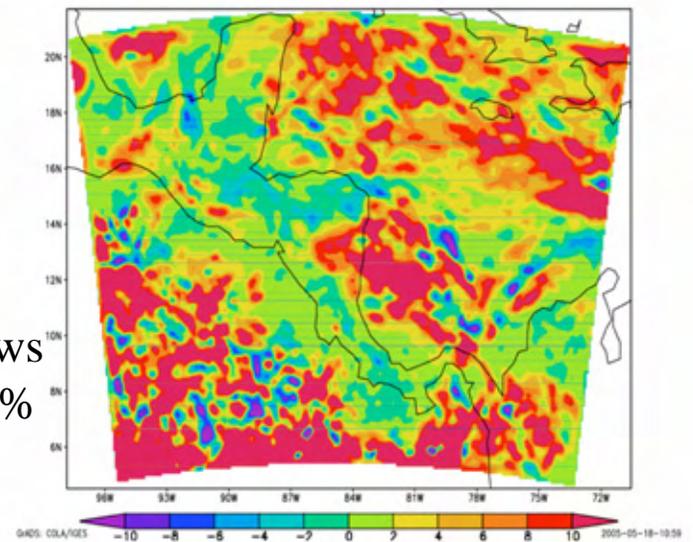
Mesoamerican Deforestation Scenarios – Implications for Wet and Dry Seasons (MM5)



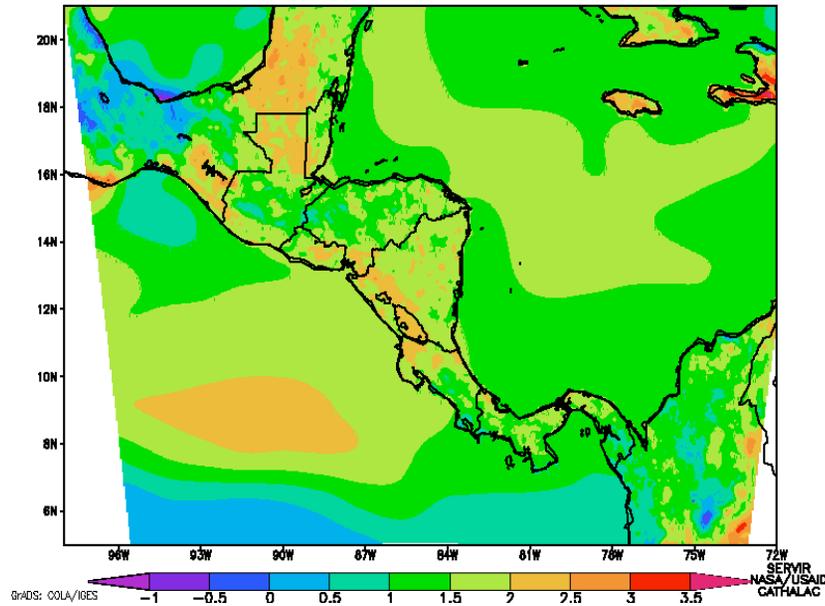
January (dry season)
Temperature (left) –
warms everywhere
but only by 1-2deg C
Rainfall (right) - little
impact as it's the dry
season!



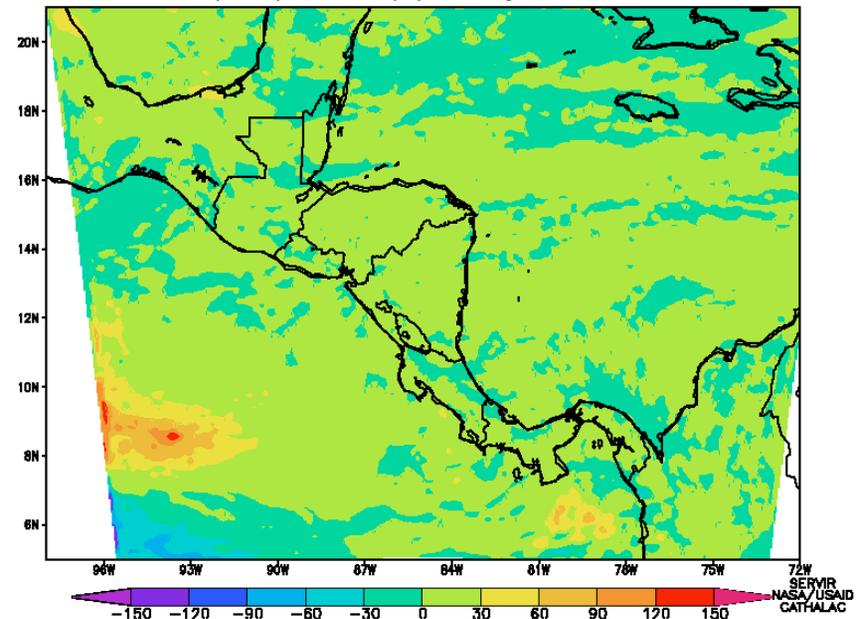
July (wet season)
Temperature (left)
warms everywhere,
but now as much as
2-5 deg C.
Rainfall (right) shows
a decrease of 20-30%
over much of the
Mayan region



Diferencias en temperatura superficial(k) en agosto, 2050–2005



Diff. de precipitacion (%) en agosto, 2050–2005

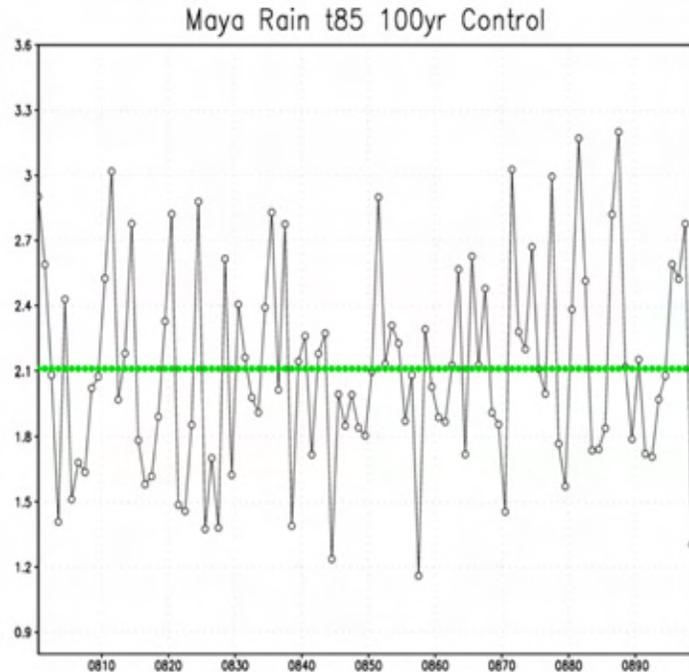


August surface temperature difference (left) and precipitation difference (right) between a run with MM5 forced by a GCM run with an IPCC 'business as usual' (global warming) Scenario for 2050 and a 2005 'present Day' control.

A fairly large warming of 1-2.5 deg C is seen, though still much smaller than that due to deforestation. Only small changes in precipitation are seen, with a general decrease in trade wind rain along the Caribbean coast, and general increase elsewhere.

We conclude the effects due to deforestation can be larger than due to global warming!!

CCSM3

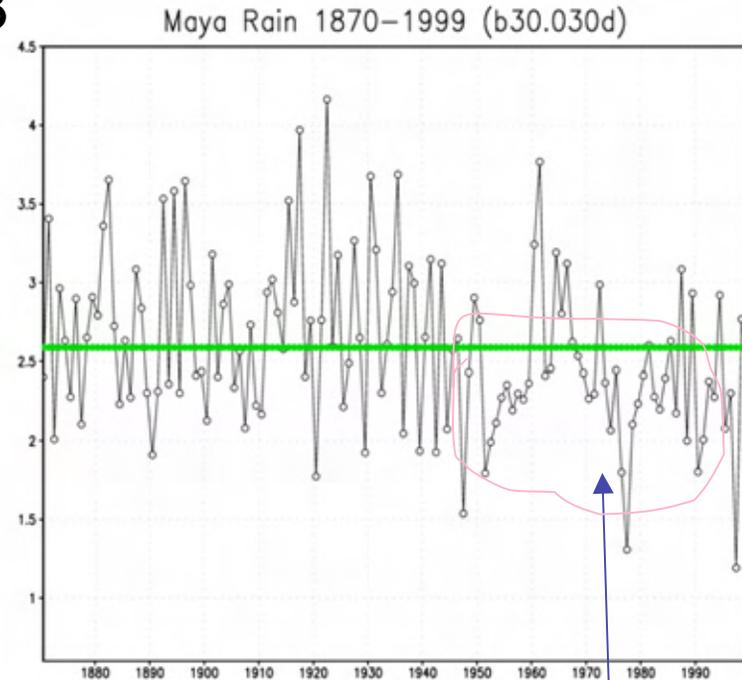


GHGS: COLA/GES

2005-06-27-14:25

This plot shows rainfall over the Maya 'lowland' region for the 'wet' season (June-September) for 100 years of 'present-day' conditions as simulated by a global climate model.

Many periods of 3-4 successive dry years can be seen, but few prolonged droughts.



GHGS: COLA/GES

2005-06-27-13:14

This plot shows rainfall for the wet season for a model simulation of the period 1870-1999.

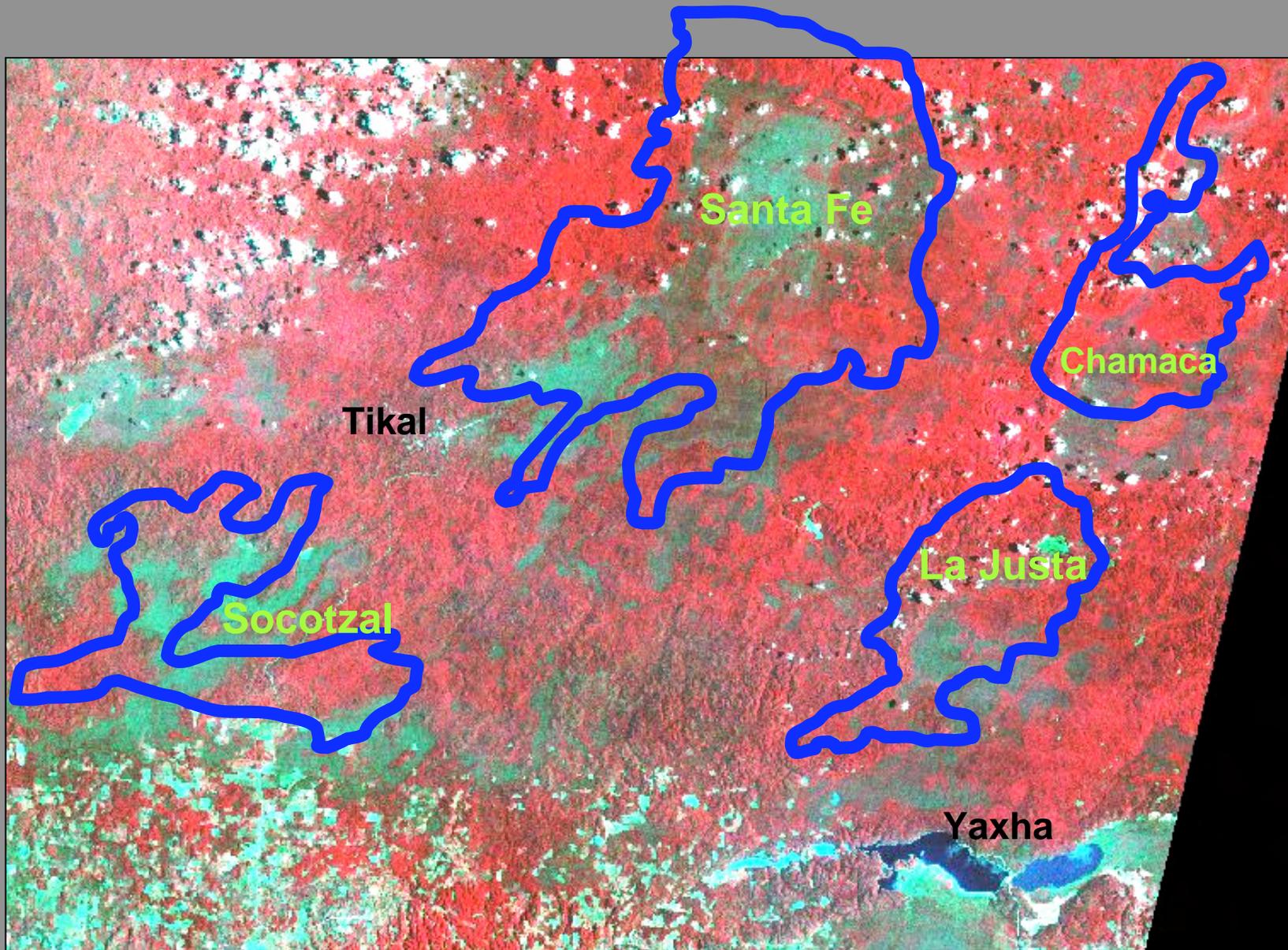
Note much more prolonged periods of drought, e.g., 1952-1981, during which 24 of 30 years have below average rain.

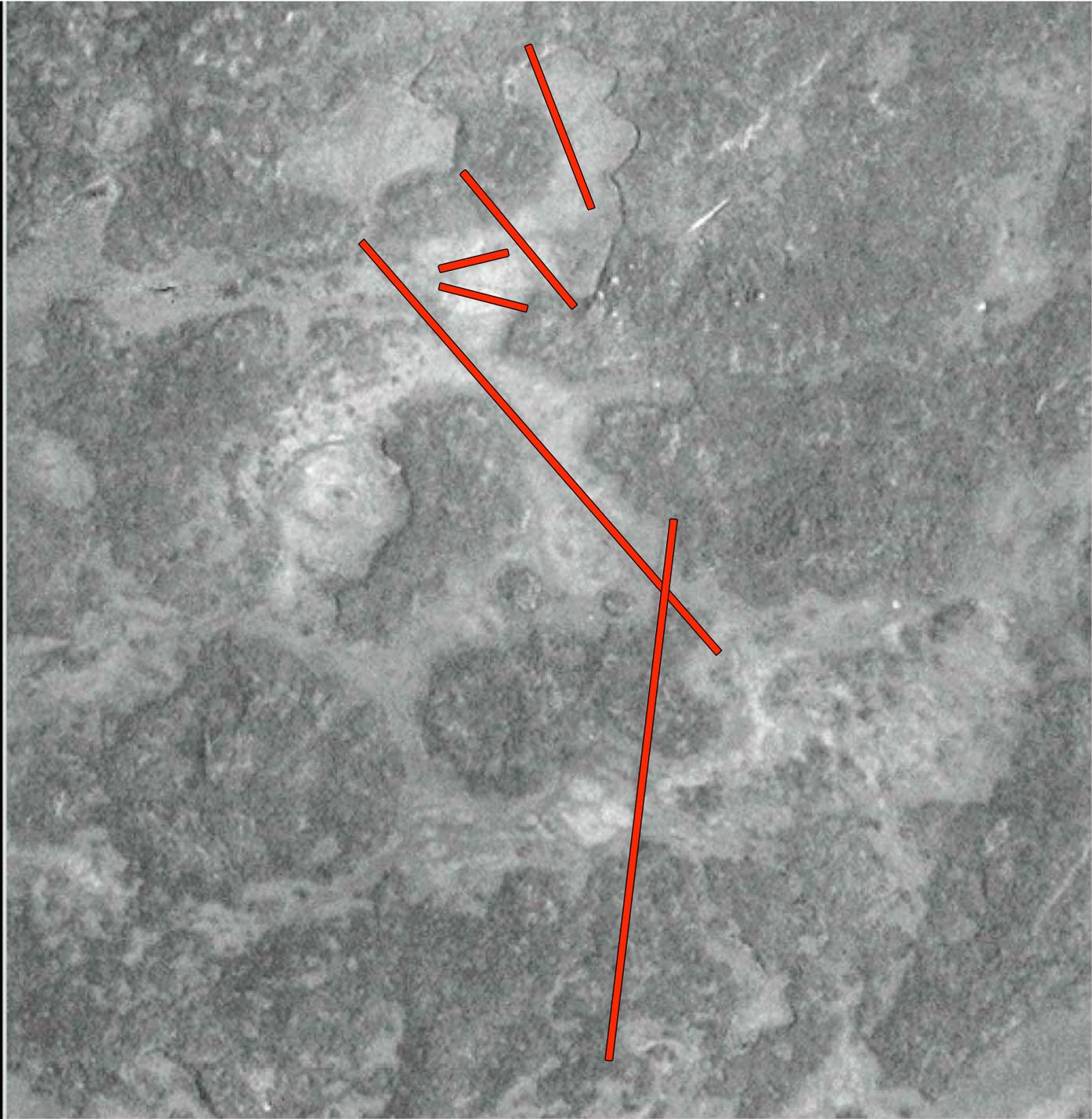
(Community Climate System Model)

Where we stand; Where we are going

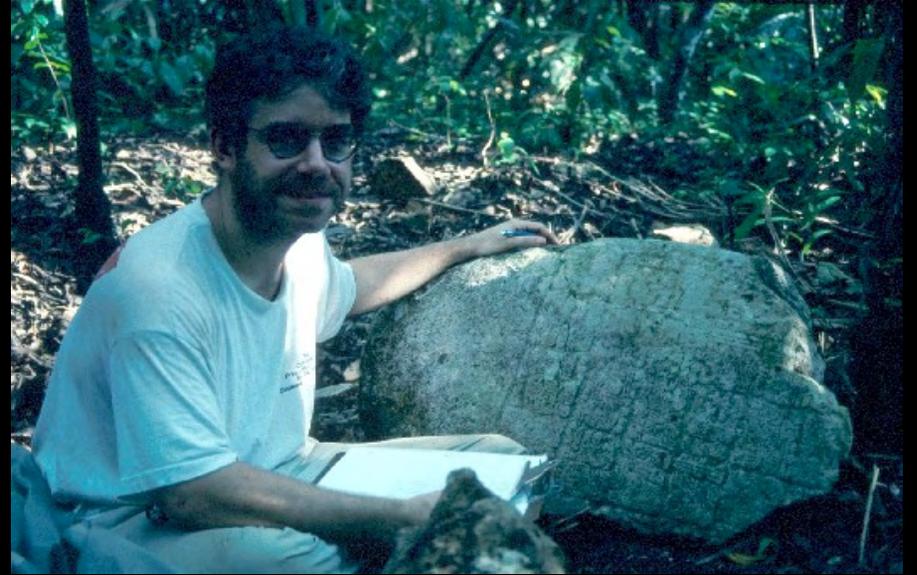
- Effects of deforestation on climate are larger than those projected for the rest of this century from 'global warming'
- Combination of deforestation-induced drying and natural drought may well have led to the collapse of the Maya civilization
- Much of the climatic effects due to deforestation may already be taking place in modern-day Mesoamerica.....
- ***If it happened to the Maya, can it happen again?***
- ***What to do next*** - targeted analyses of global climate models (e.g., NCAR CCSM3) and regional climate model runs (MM5/WRF) to evaluate combined effects of human and natural droughts
- Examination of underlying physical mechanisms, using RAMS forced by the MM5/RAMS simulations

Bajos: 40-60% of the Land Surface

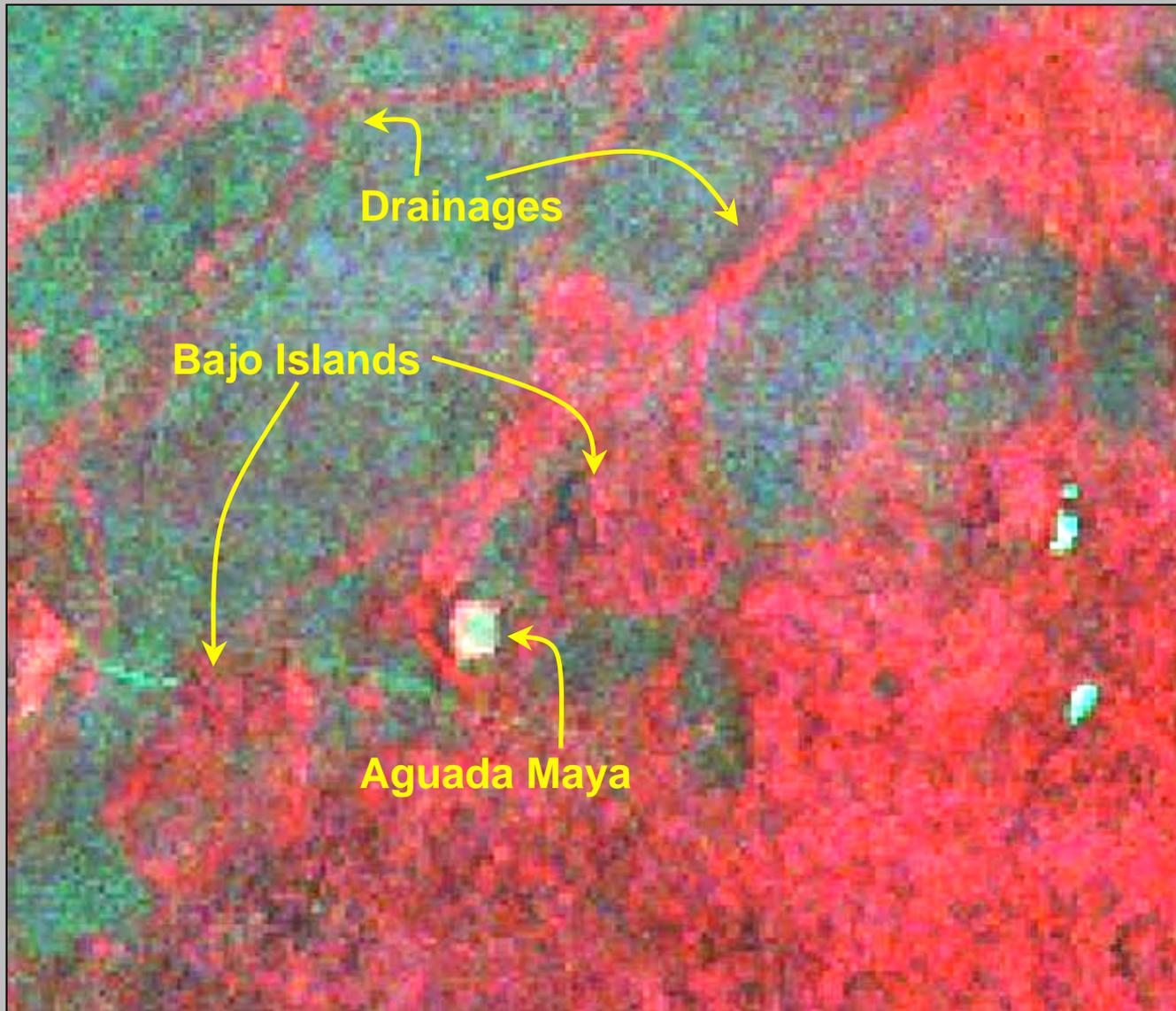








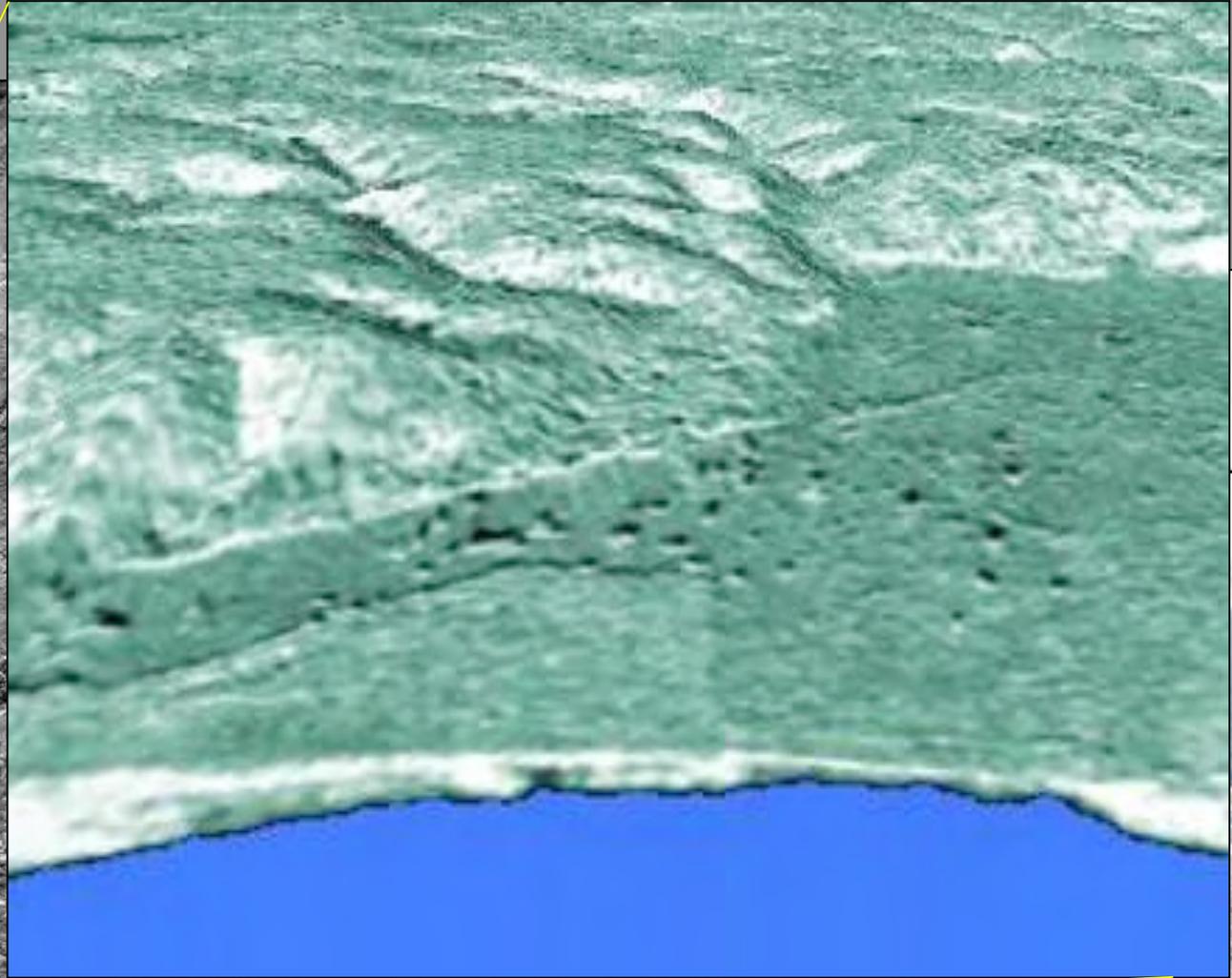
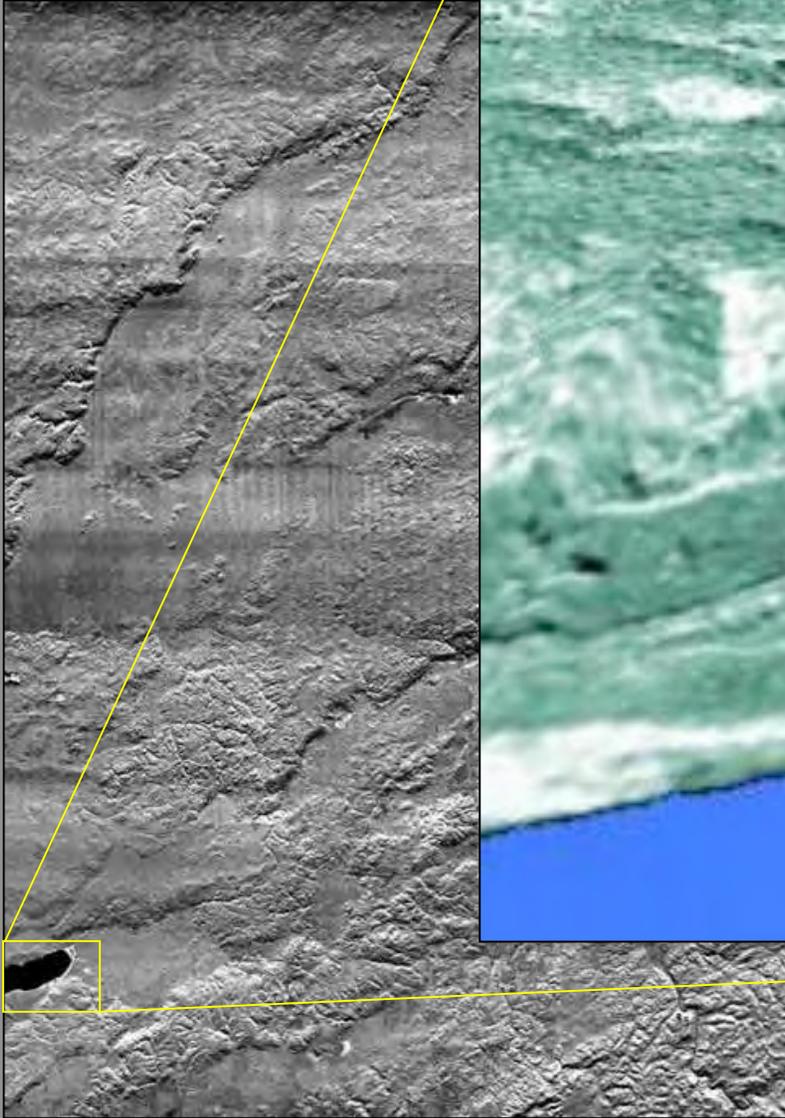
Bajo La Justa

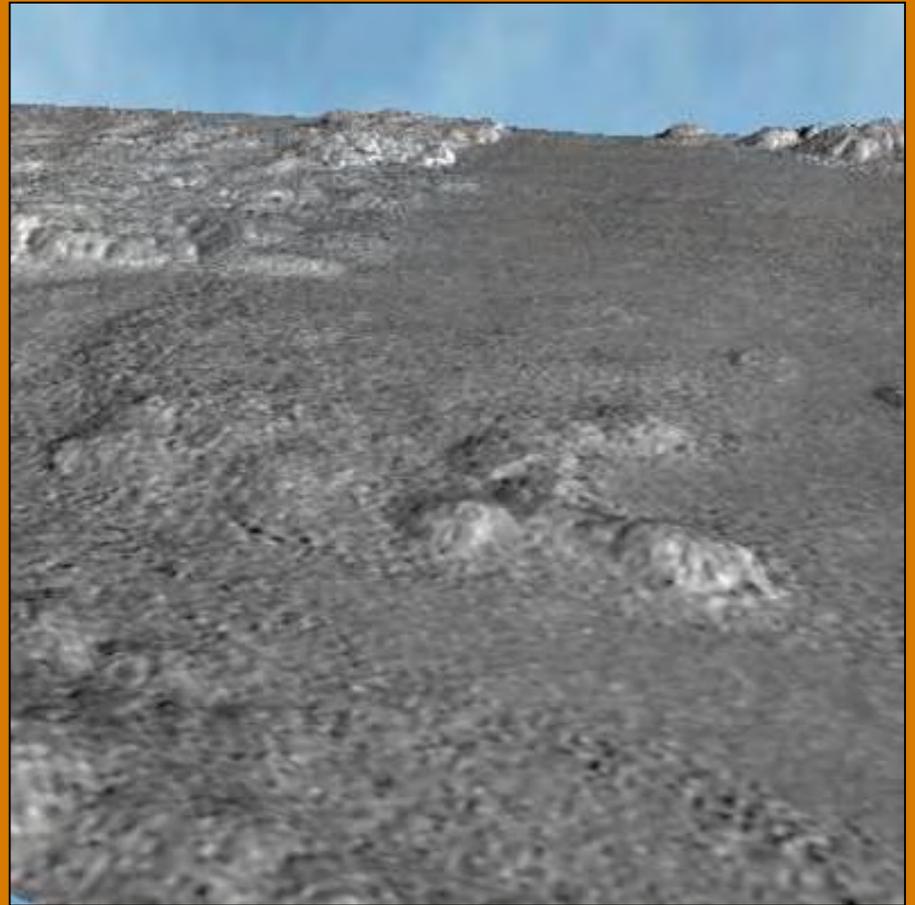
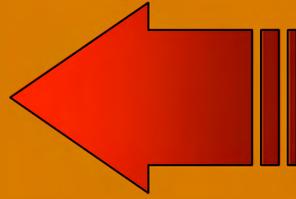
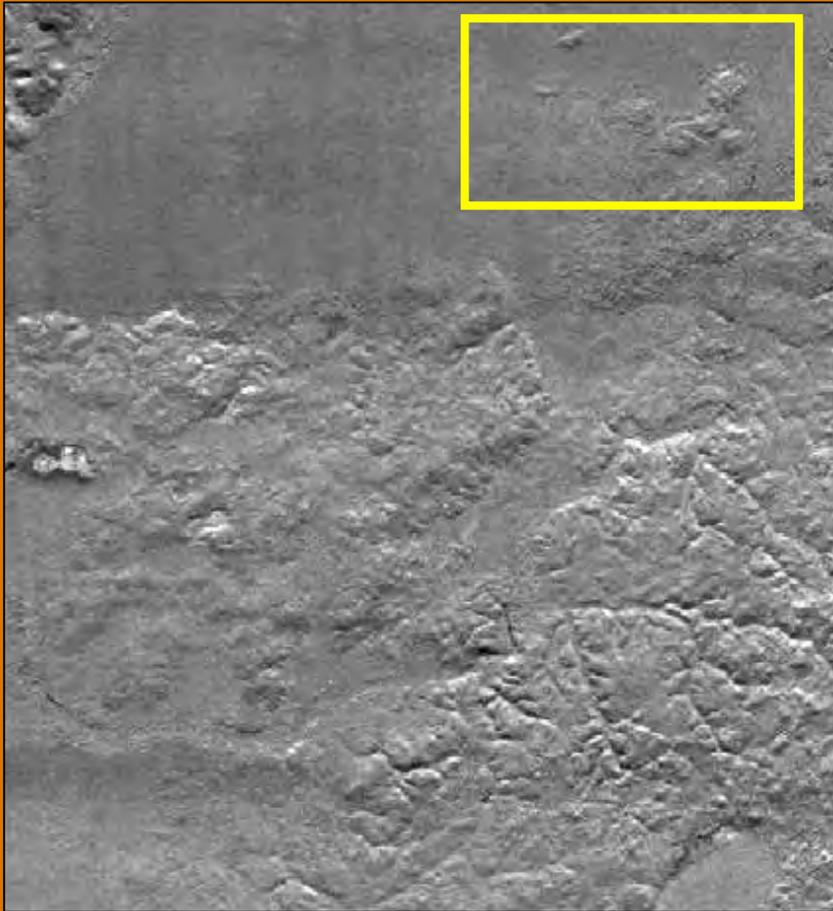


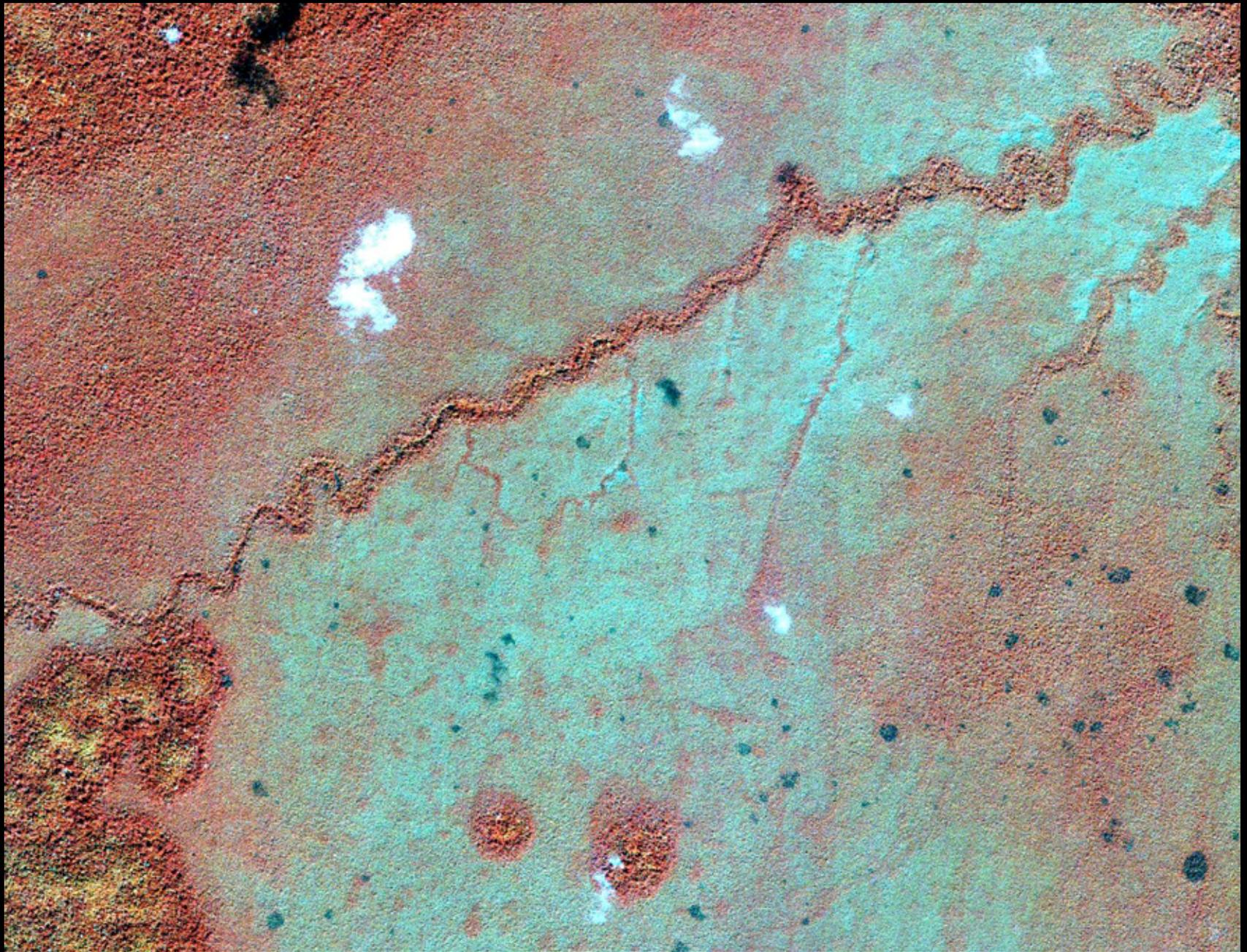












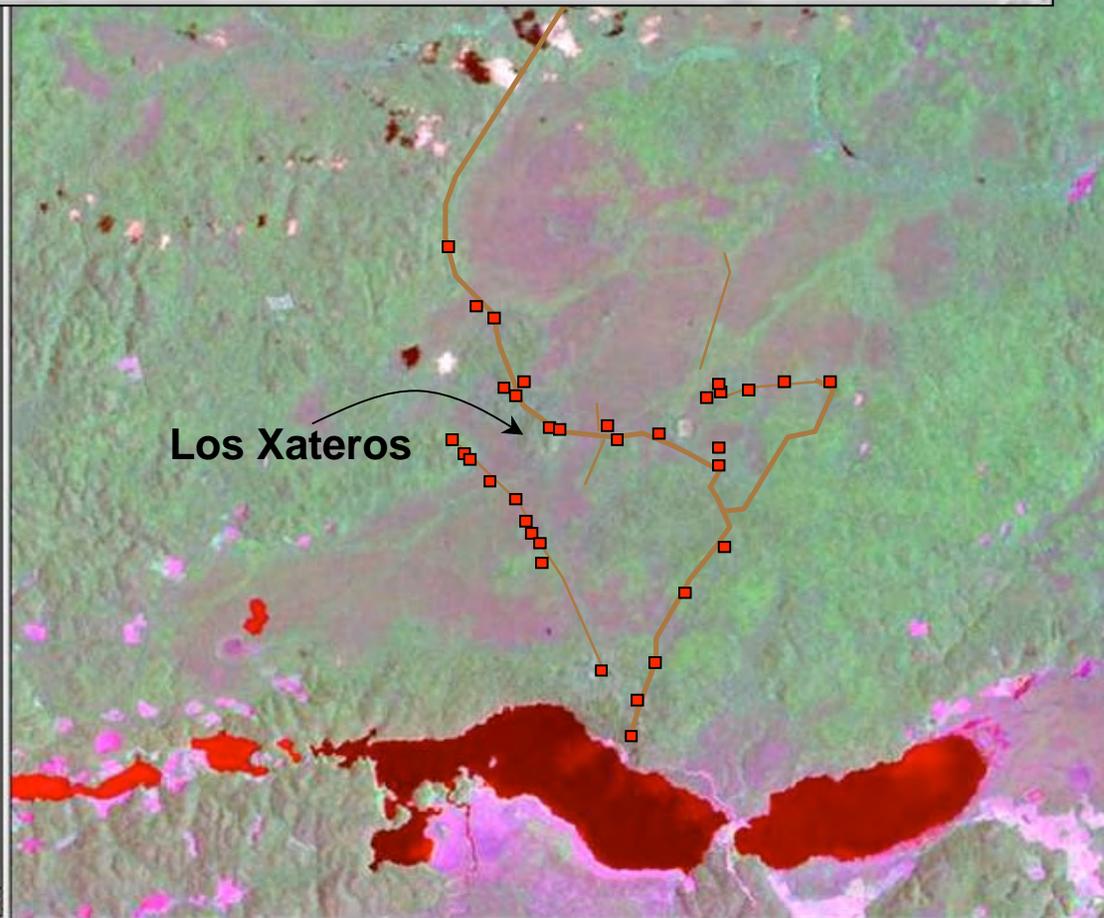
| Shape | Station | Transect | Vegetation | Name |
|-------|---------|----------|--|-------------|
| Point | 102 | Brecha 1 | Palm Bajo | MALER |
| Point | 401 | Brecha 1 | Palm Bajo -> Transitional Palm/ Arbusto | B1P01 |
| Point | 107 | Brecha 1 | Transitional Palm/ Arbusto | 1996 Trench |
| Point | 403 | Brecha 1 | Transitional Palm/ Arbusto -> Palm Bajo | B1P04 |
| Point | 404 | Brecha 1 | Palm Bajo -> Transitional Palm/ Arbusto | B1P05 |
| Point | 405 | Brecha 1 | Transitional Palm/ Arbusto -> Arbusto + Zacate | B1P06 |
| Point | 406 | Brecha 1 | Arbusto + Zacate (Arroyo Yaxha) | B1P07 |
| Point | 407 | Brecha 1 | Arbusto + Zacate -> Arbusto | B1P09 |
| Point | 408 | Brecha 1 | Arbusto -> Transitional Palm/ Arbusto | B1P10 |
| Point | 409 | Brecha 1 | Transitional Palm/ Arbusto -> Selva Alta | B1P11 |
| Point | 410 | Brecha 1 | Selva Alta | B1P12 |

View Theme Surfa



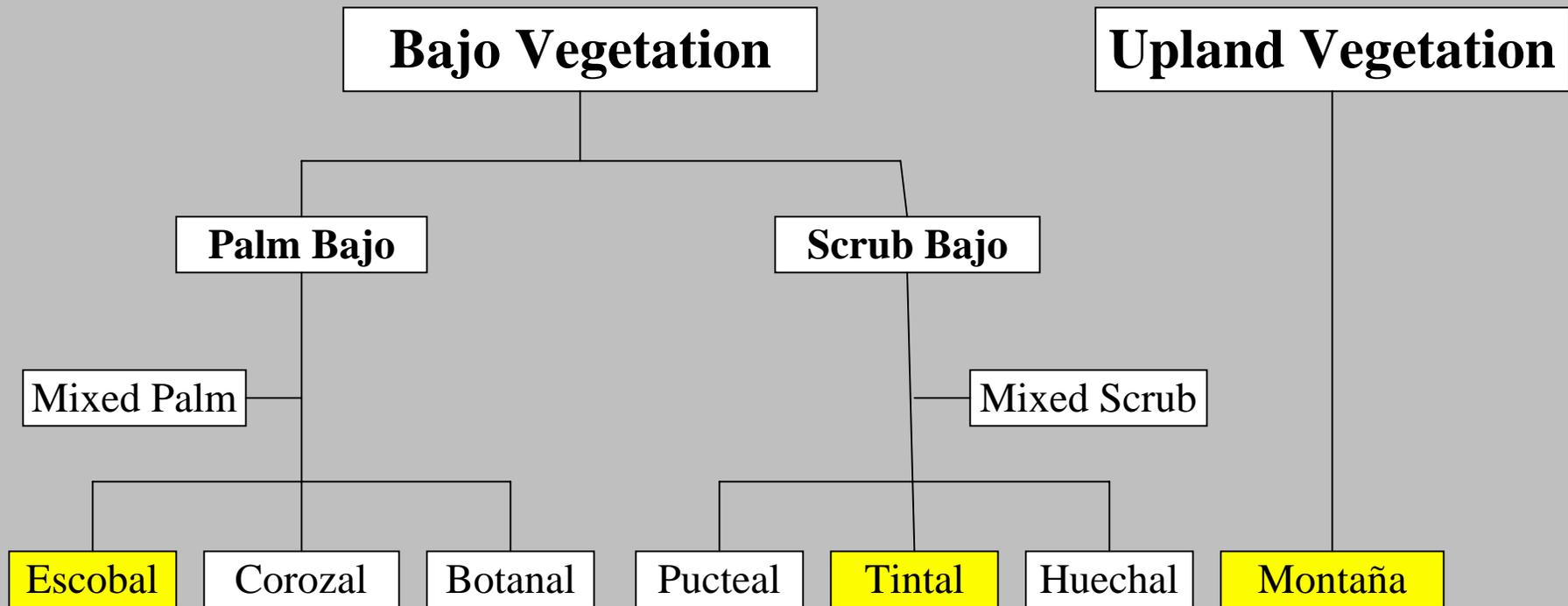
View1

- Vegetation_tran
- Losxateros.shp
- Points.shp
- Elbayal.shp
- Brechas.shp
- Arroyos.shp
- Pochitocaroad.shp
- Yaxhanakum_road_96_99.shp
- Yaxhanakum_road_merge.shp
- Aguada_maya.shp
- Yaxja_utm16.gis
- Tm1997_346_subset.img



238,301.49
1,886,032.80

Petén Vegetation Classes

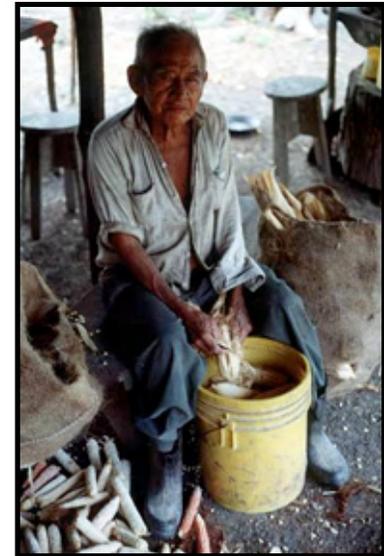


The three most prevalent land classes in the San Bartolo region are highlighted in yellow

{ IKONOS imagery can distinguish between the groups:
Palm Bajo, Scrub Bajo, and Upland Vegetation }

The amount of land needed per nuclear family will vary according to several factors, such as:

- the size of the nuclear family
- the integration of the household into the market (selling surplus maize for profit)
- the feeding of maize to domestic animals, such as pigs
- relative yields in the area
- risk-aversion strategies of the farmer



An area of **1.5 ha** of farmed land per nuclear family accords well with the observed data from Yucatan for a typical subsistence-oriented household.

Agricultural Landscape of a 1:20 Year Fallow System

Per household:

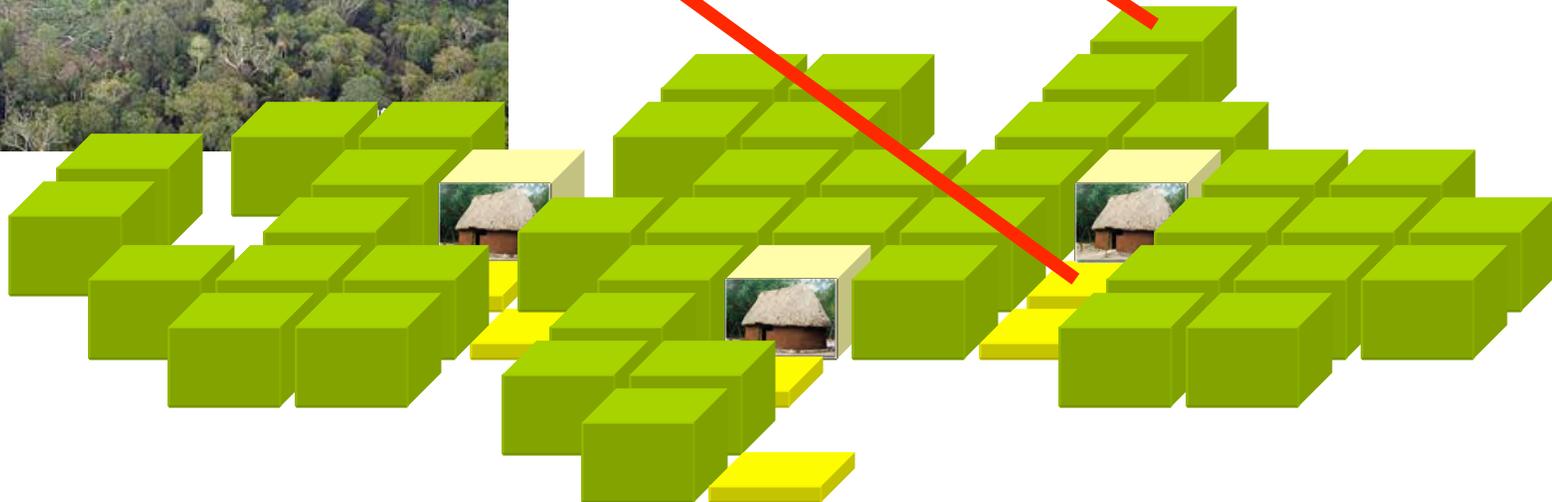
- 2 fields in use
- 20 short-fallowed fields
- 20 long-fallowed fields



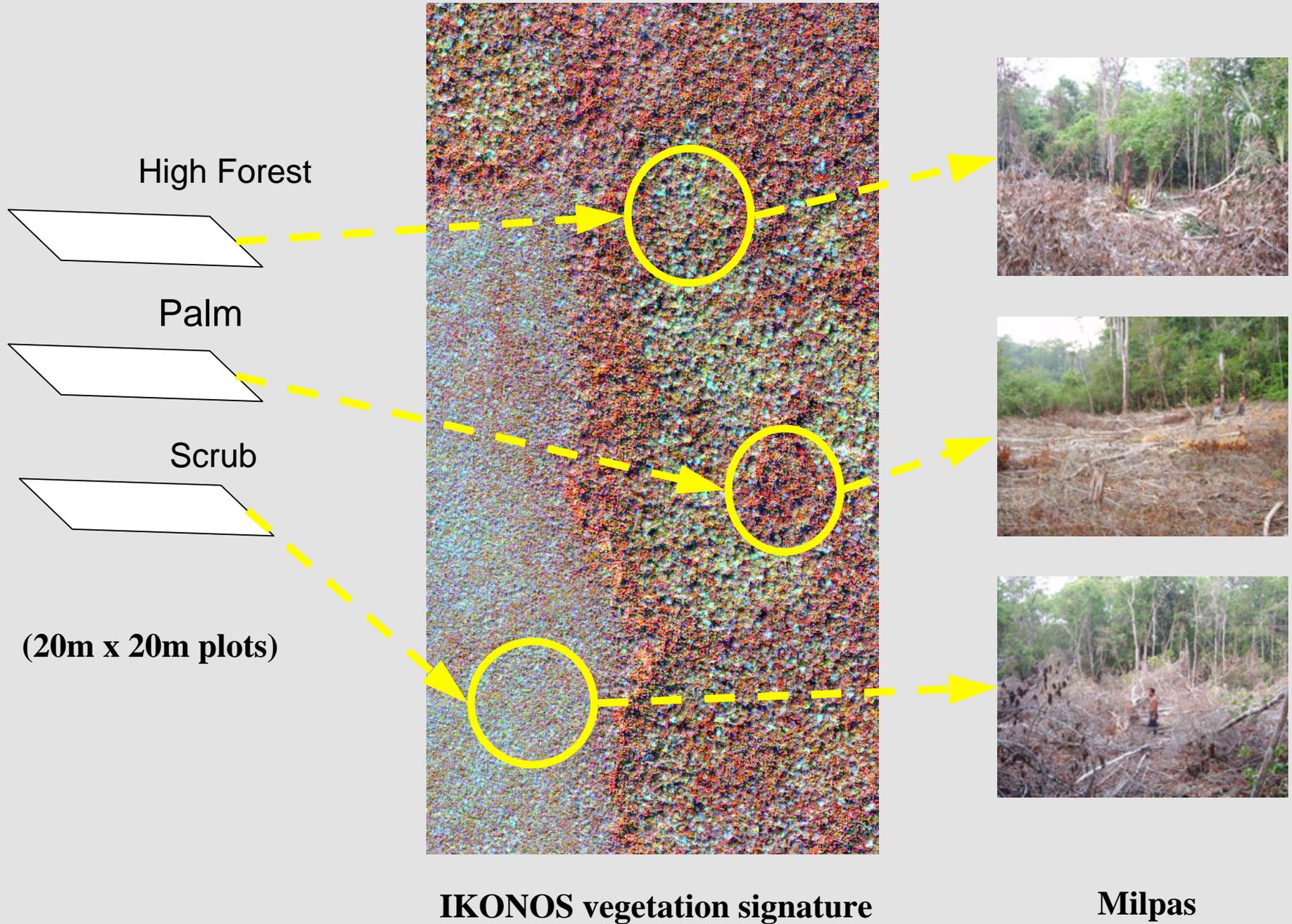
Agricultural Landscape of a 1:7 Year Fallow System

Per household:

- 2 fields in use
- 14 short-fallowed fields



Planning experimental maize fields using IKONOS data





Halfway to harvest: July 2005

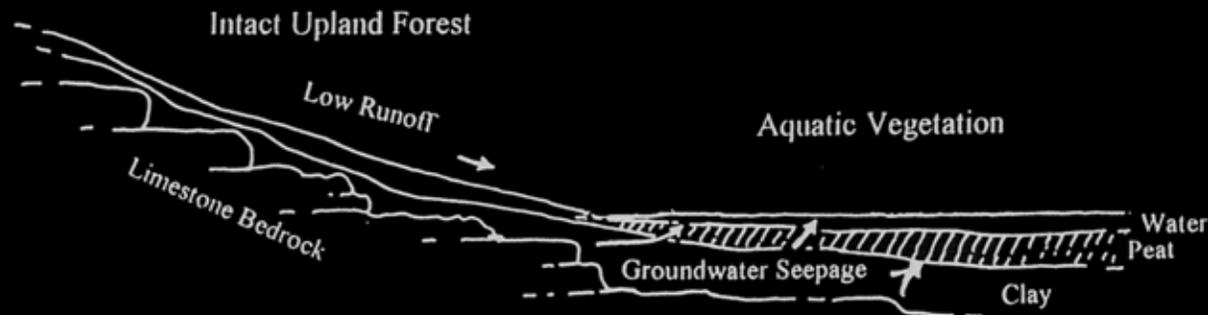


Note the differences in the health and maturity of the maize plants grown in these different environments.



Deforestation during the Maya period changed the nature of bajos, creating different and less productive agricultural landscapes.

Antes de la deforestación



Después de la deforestación



“The greatest human-induced environmental transformation in the history of the Pre-Columbian New World.” (Dunning 2003).

NATIONAL GEOGRAPHIC MAGAZINE

December 2003

NATIONAL
GEOGRAPHIC
RESEARCH AND
EXPLORATION



GRANTEE

William Saturno, assistant professor at the University of New Hampshire and research associate at Harvard University's Peabody Museum of Archaeology and Ethnology

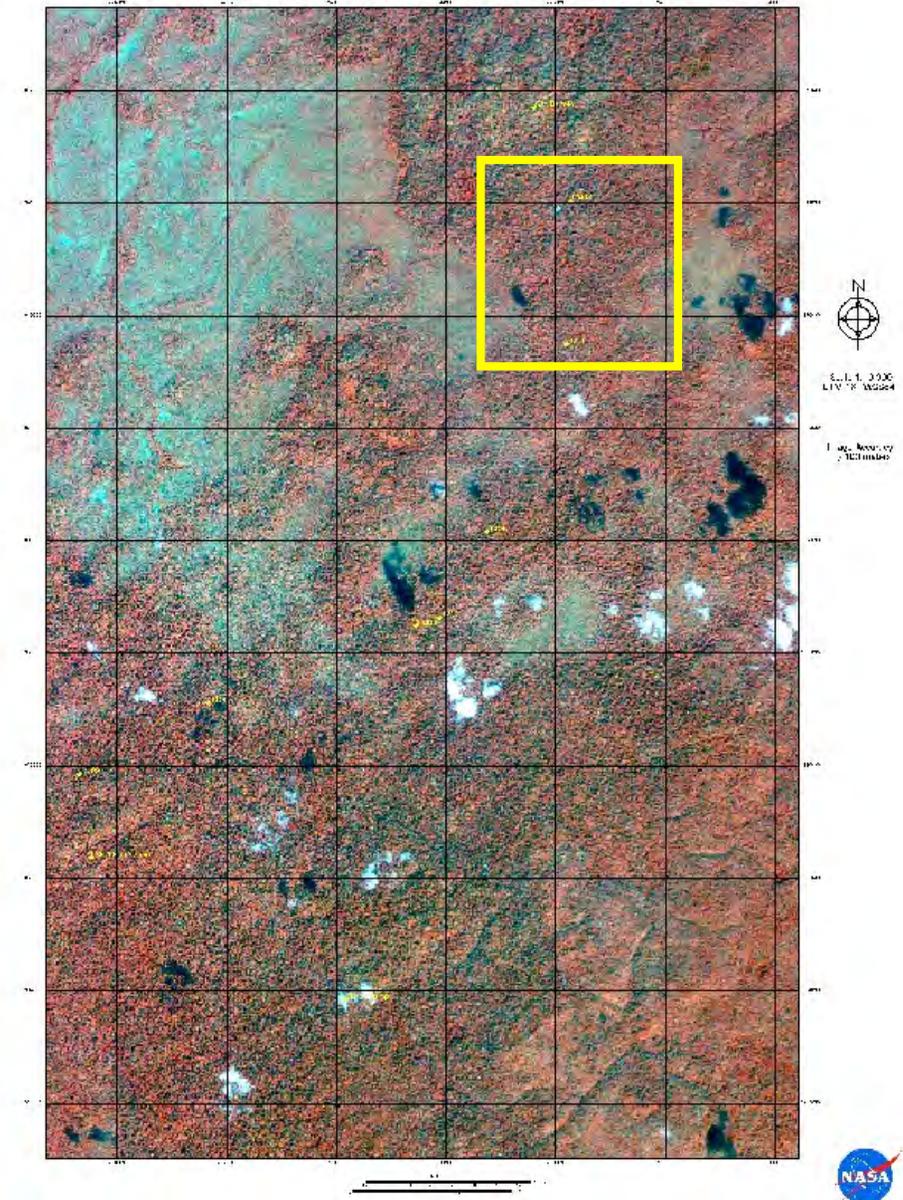
"This mural exponentially expands our knowledge of what the Maya thought important 2,000 years ago."

FIELD DISPATCH GUATEMALA

Sistine Chapel of the Early Maya

Dr. Bill Saturno

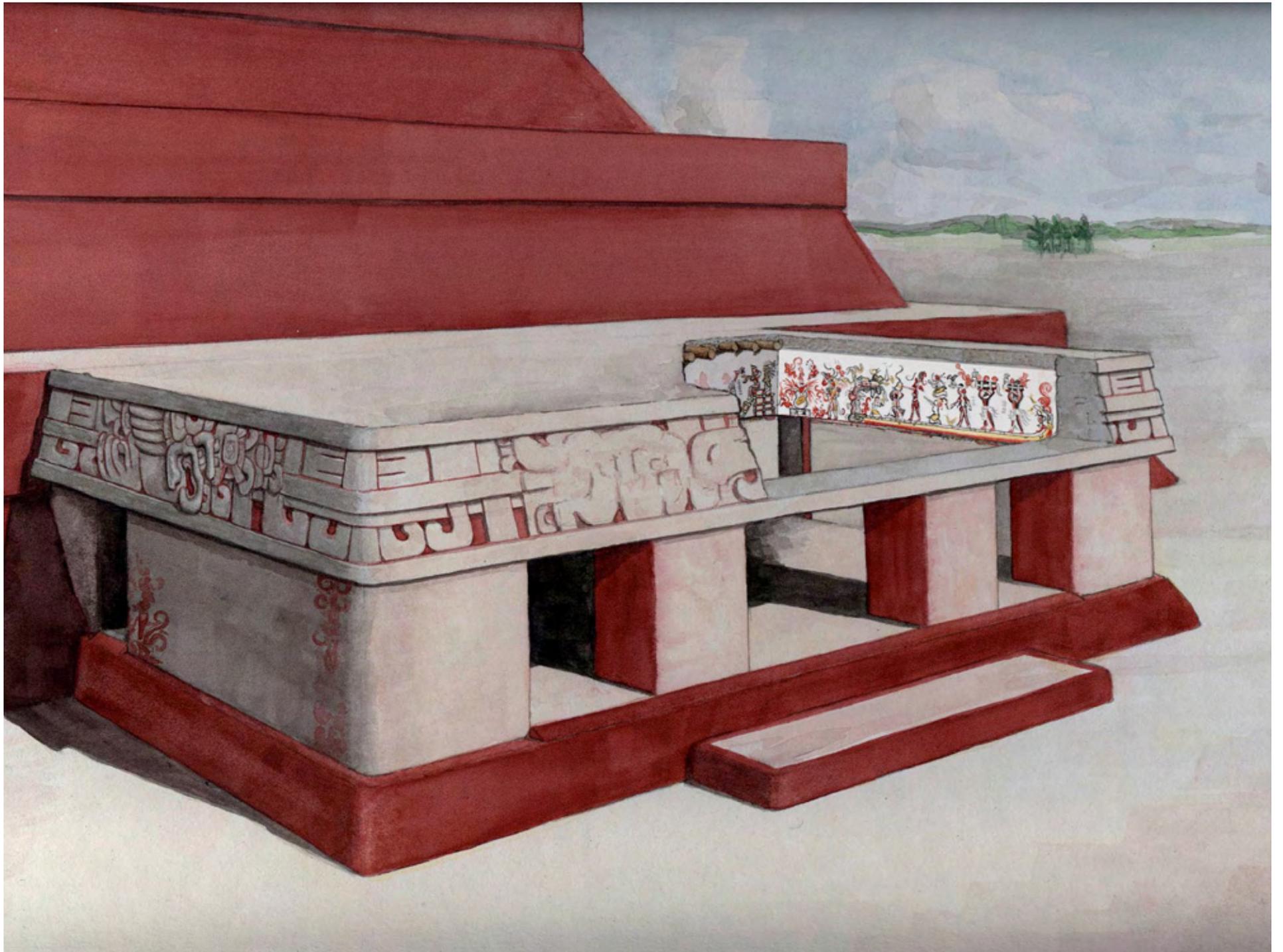
Xultún - San Bartolo Transect False Color Composition - RGB/4,3,1





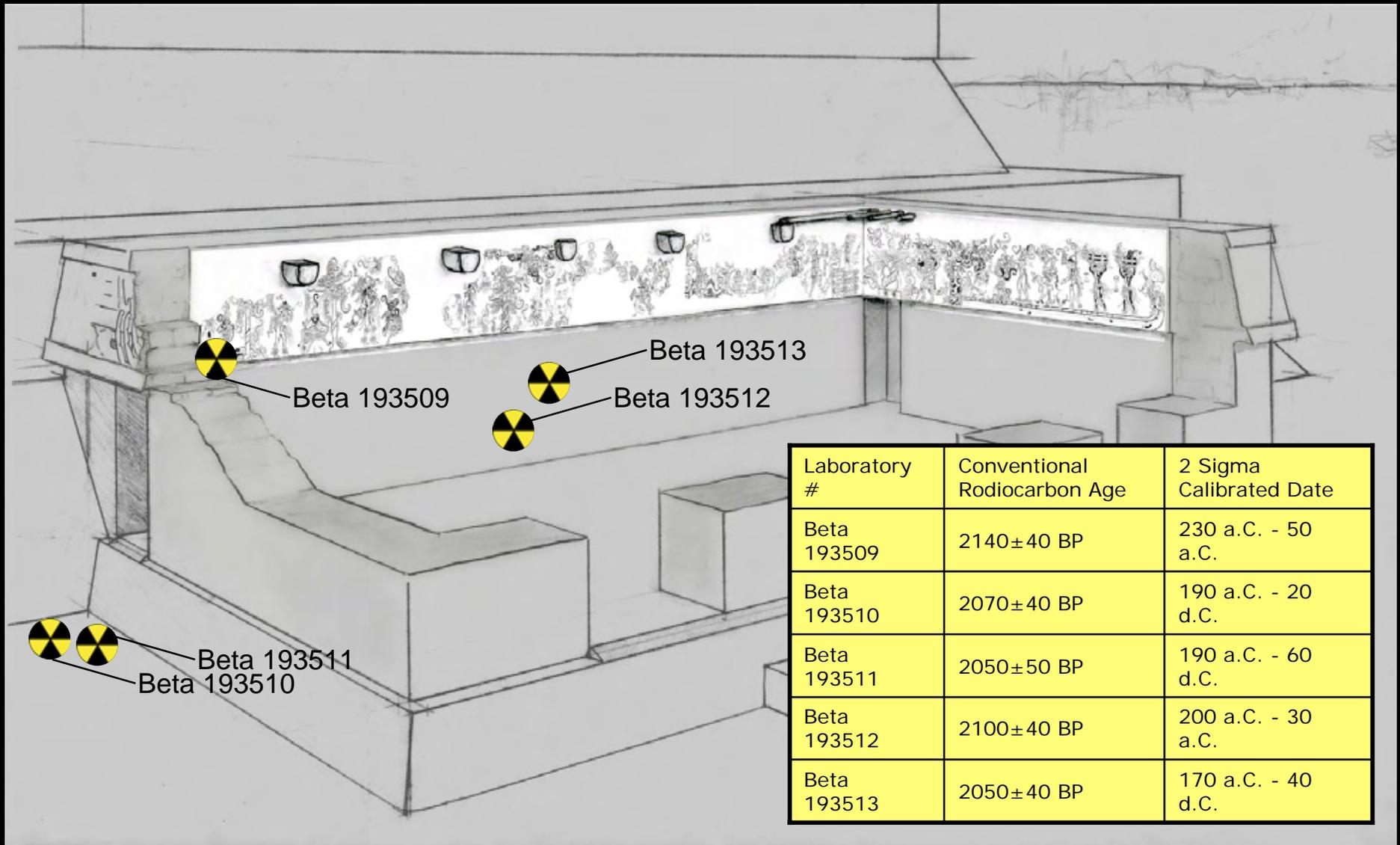


HURST L. Ashby .2001





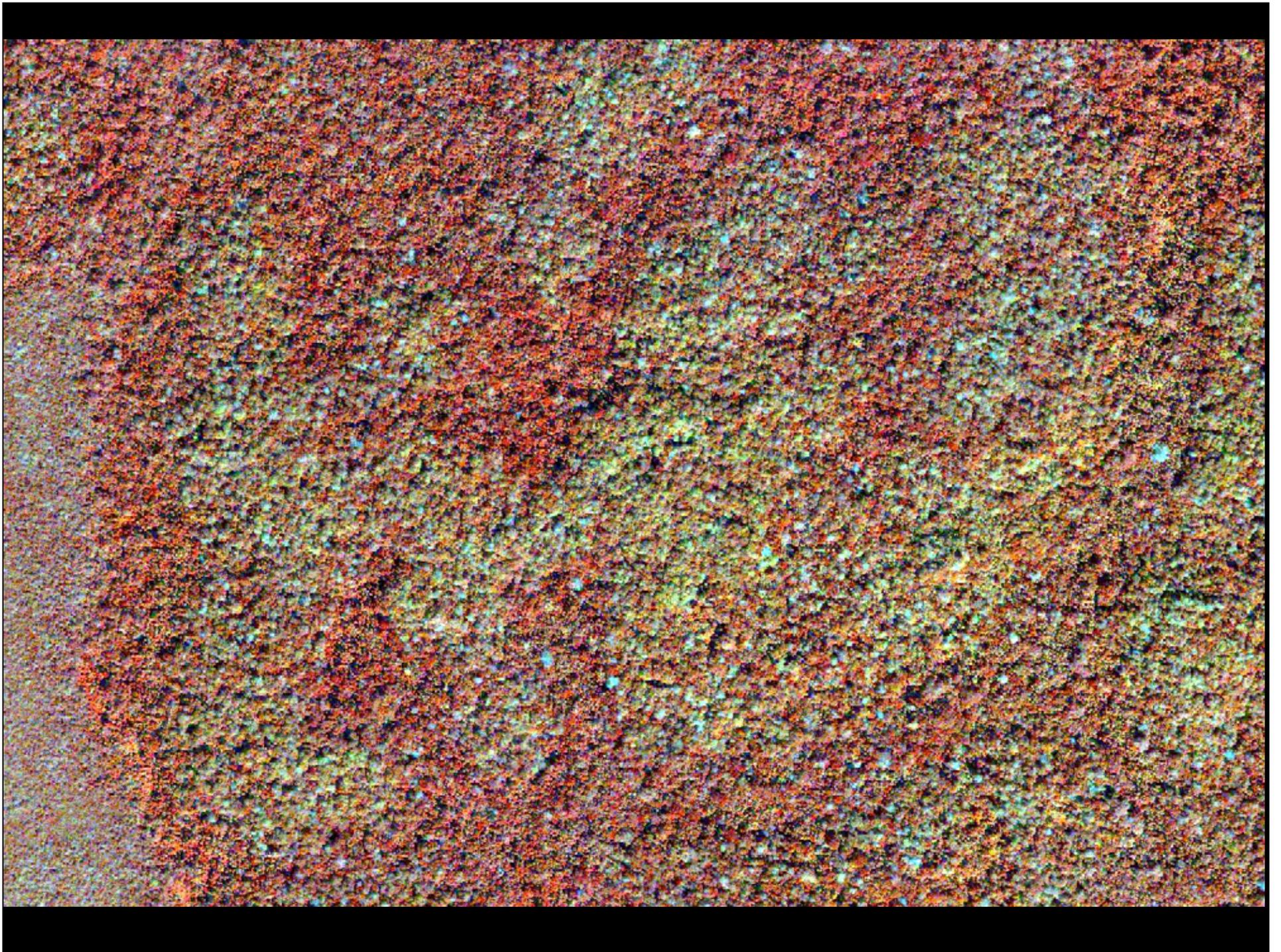
Dating the Murals in Pinturas Sub-1

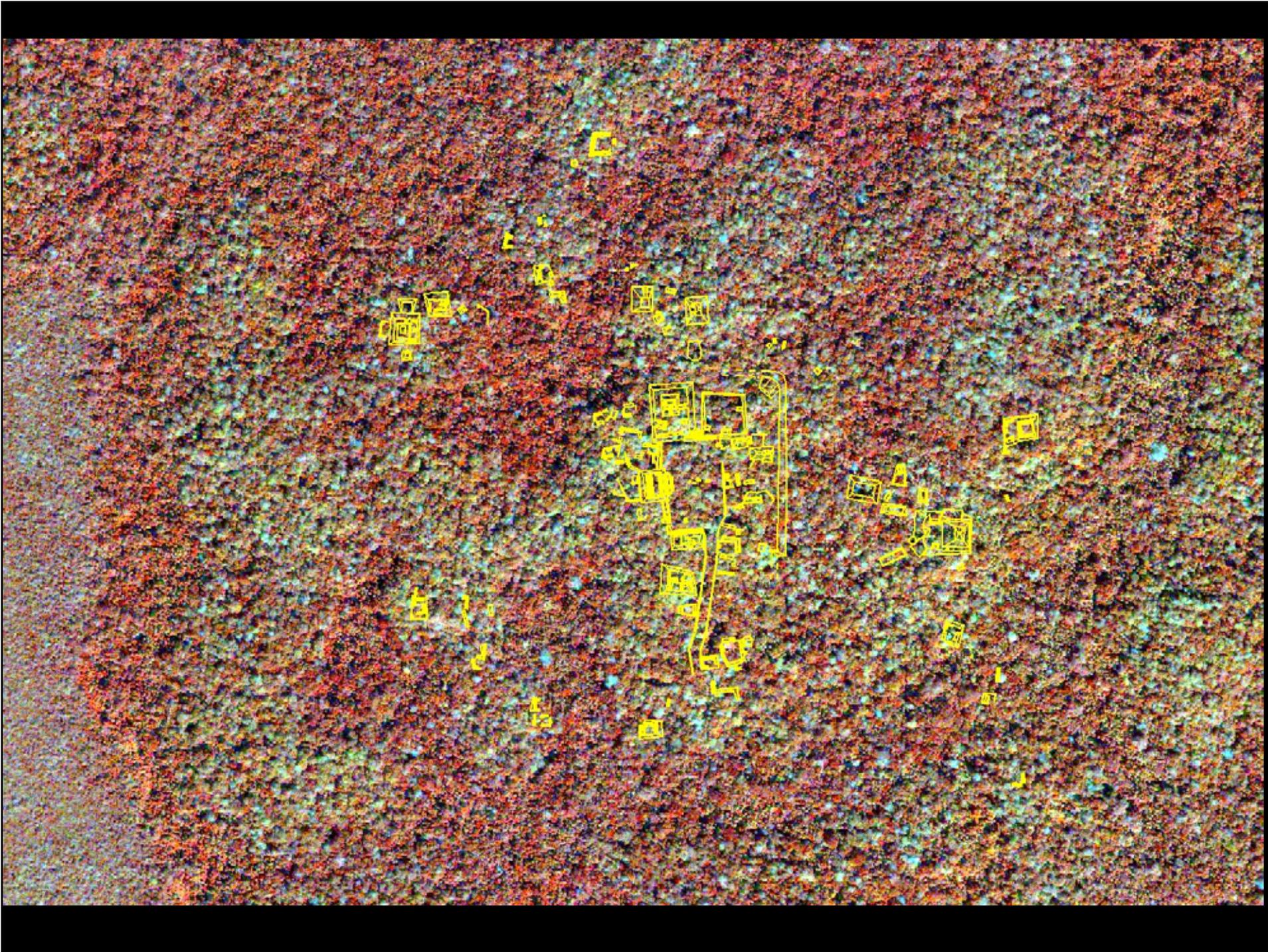


| Laboratory # | Conventional Radiocarbon Age | 2 Sigma Calibrated Date |
|--------------|------------------------------|-------------------------|
| Beta 193509 | 2140±40 BP | 230 a.C. - 50 a.C. |
| Beta 193510 | 2070±40 BP | 190 a.C. - 20 d.C. |
| Beta 193511 | 2050±50 BP | 190 a.C. - 60 d.C. |
| Beta 193512 | 2100±40 BP | 200 a.C. - 30 a.C. |
| Beta 193513 | 2050±40 BP | 170 a.C. - 40 d.C. |

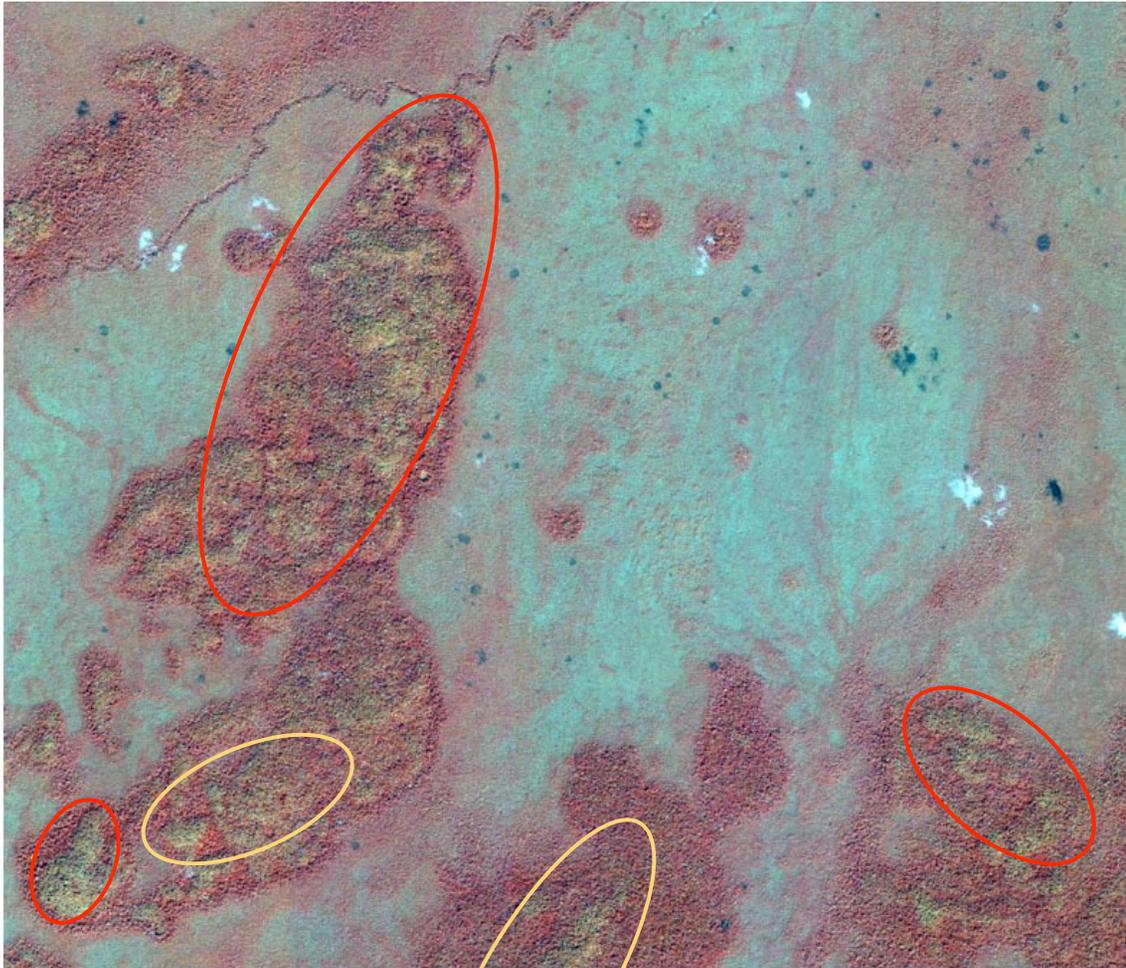




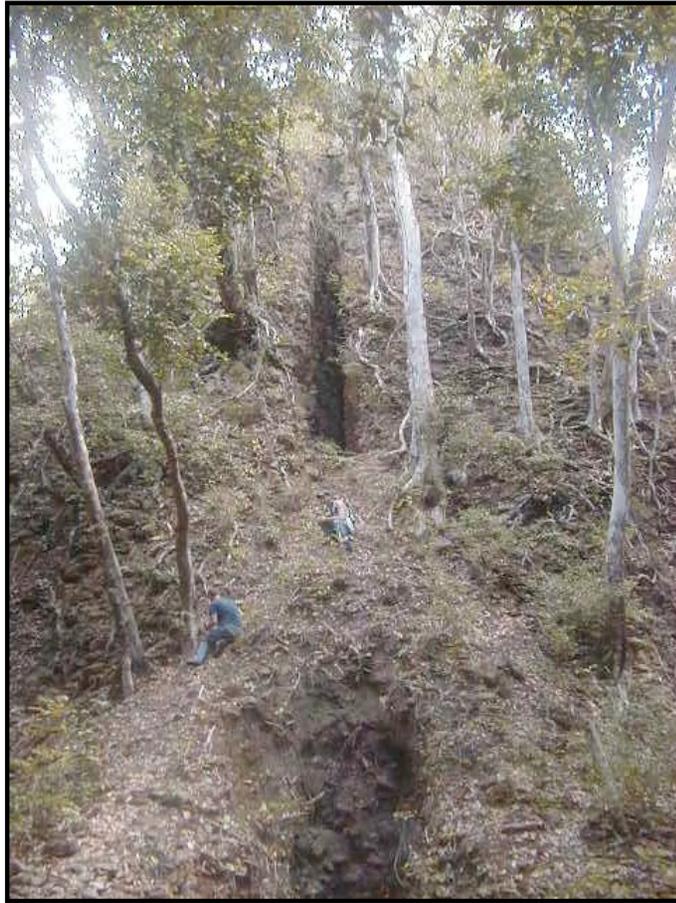




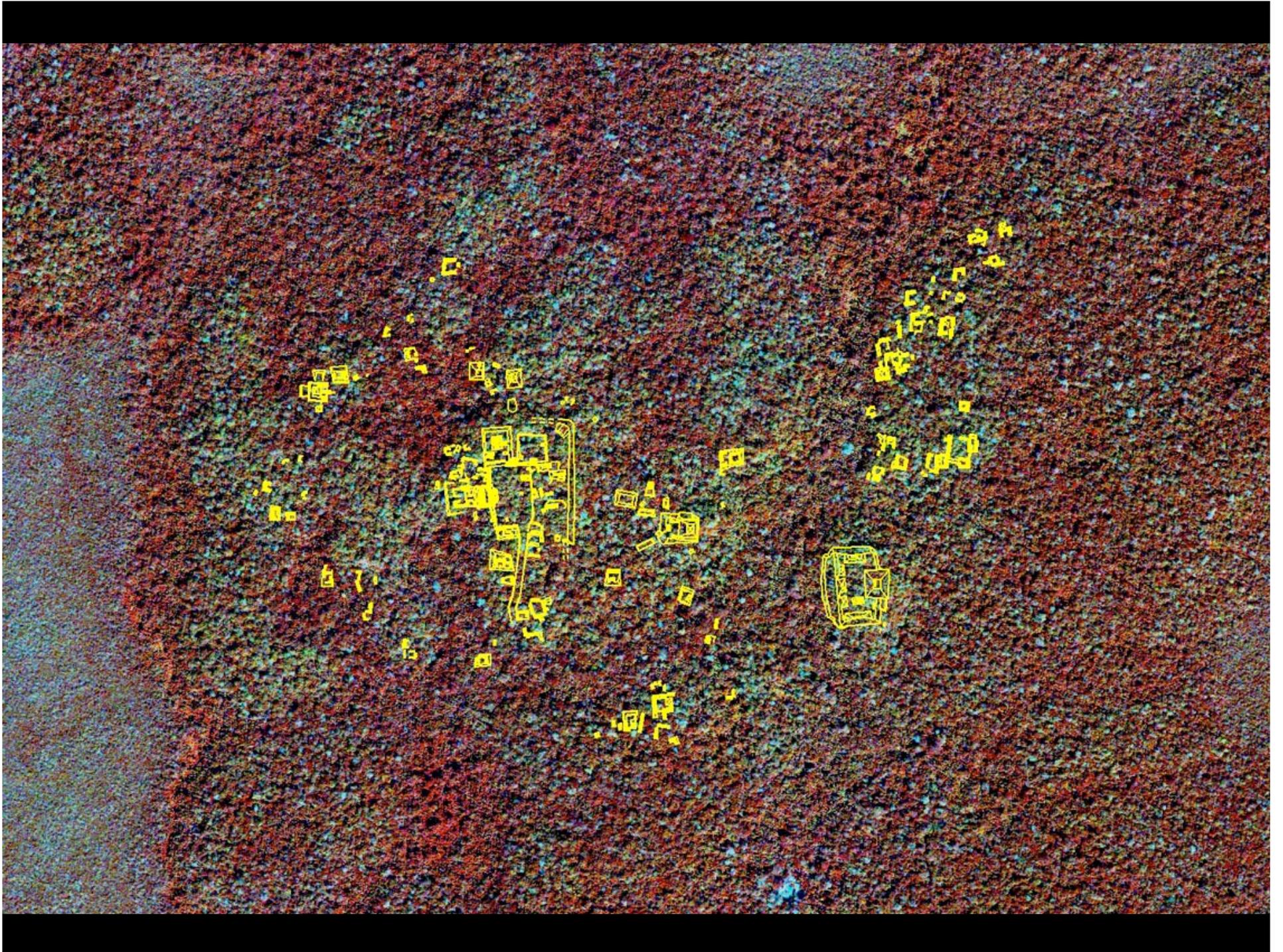
Oasis Island and The Region Northeast of San Bartolo

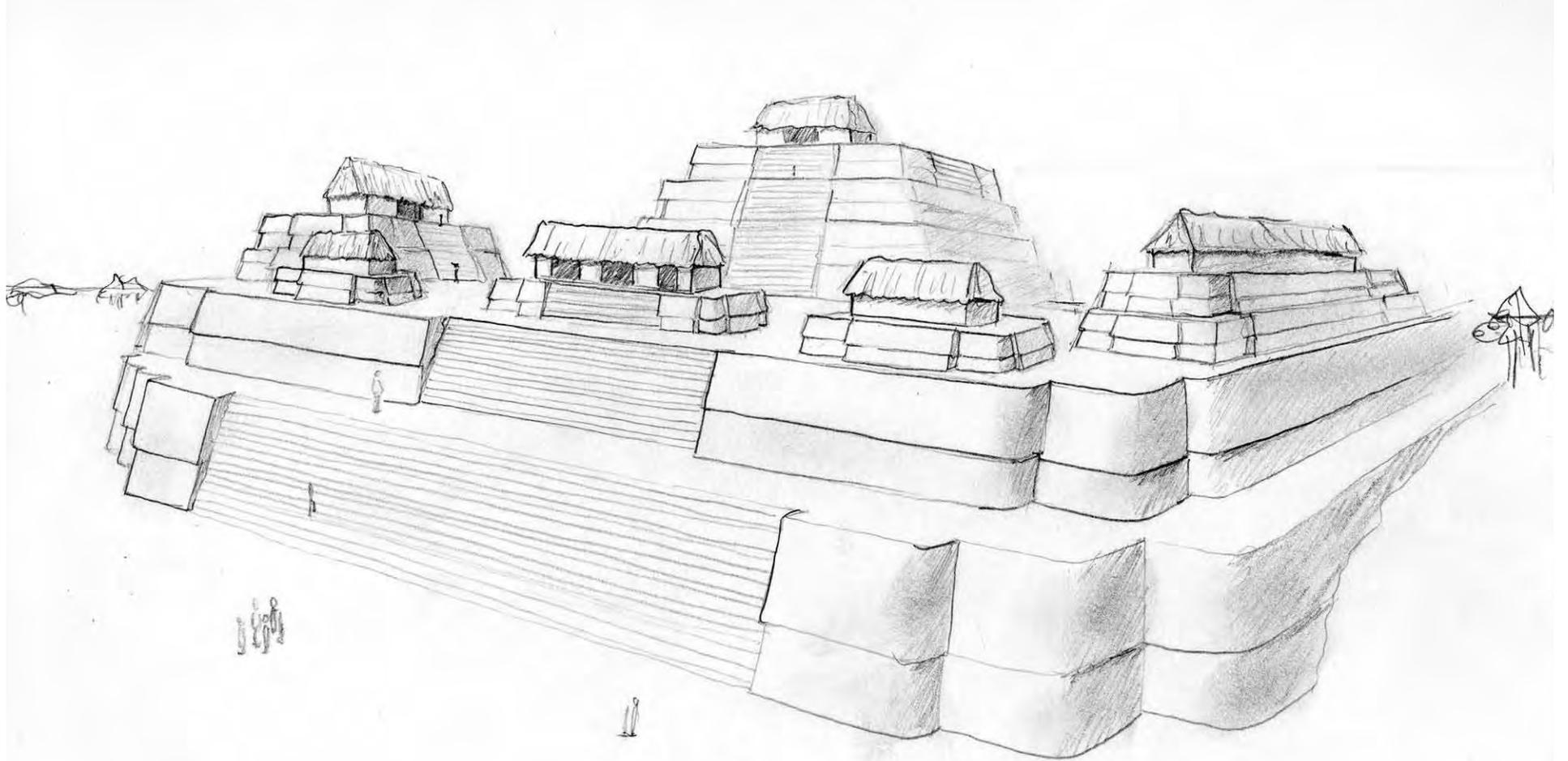


•Sites verified with
Sever and Irwin
2004



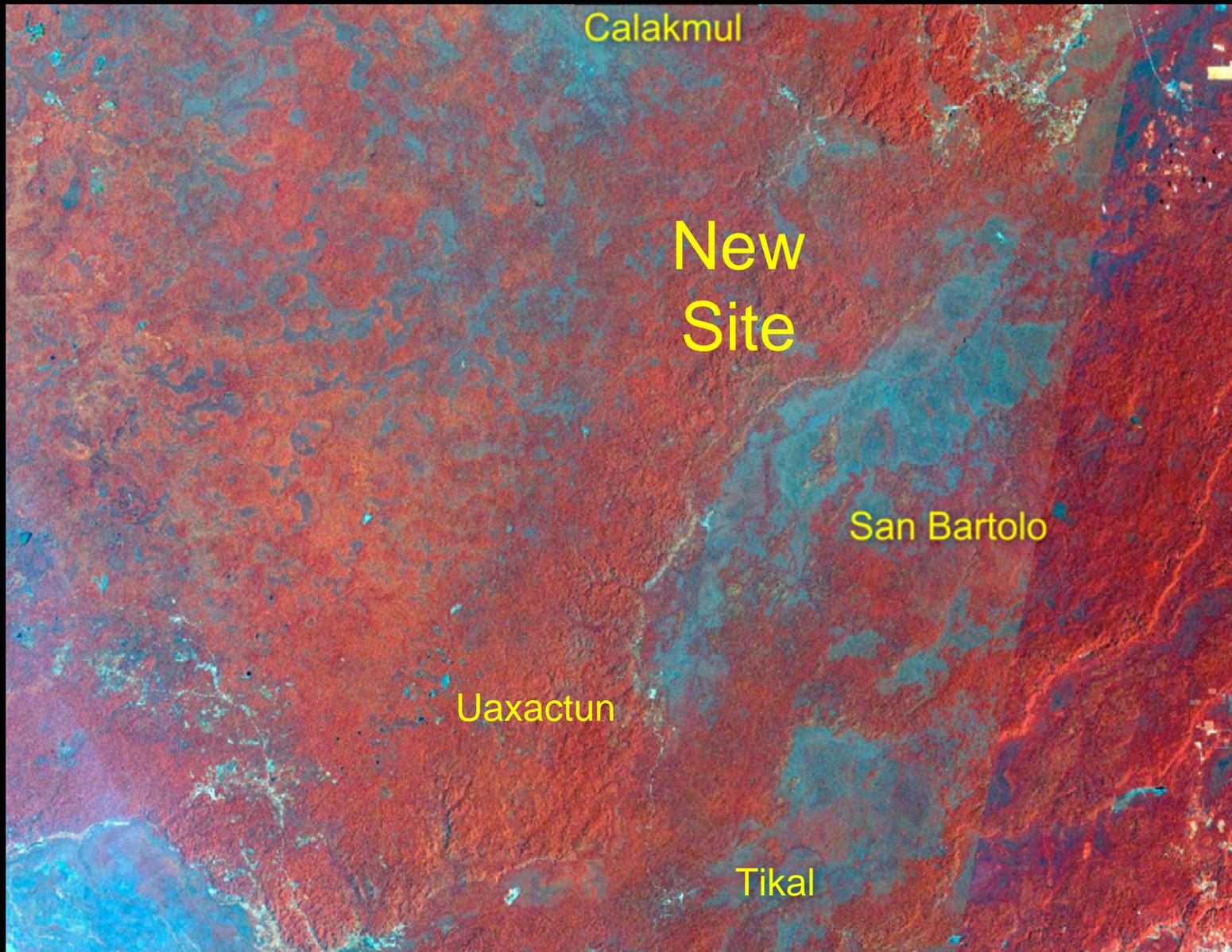






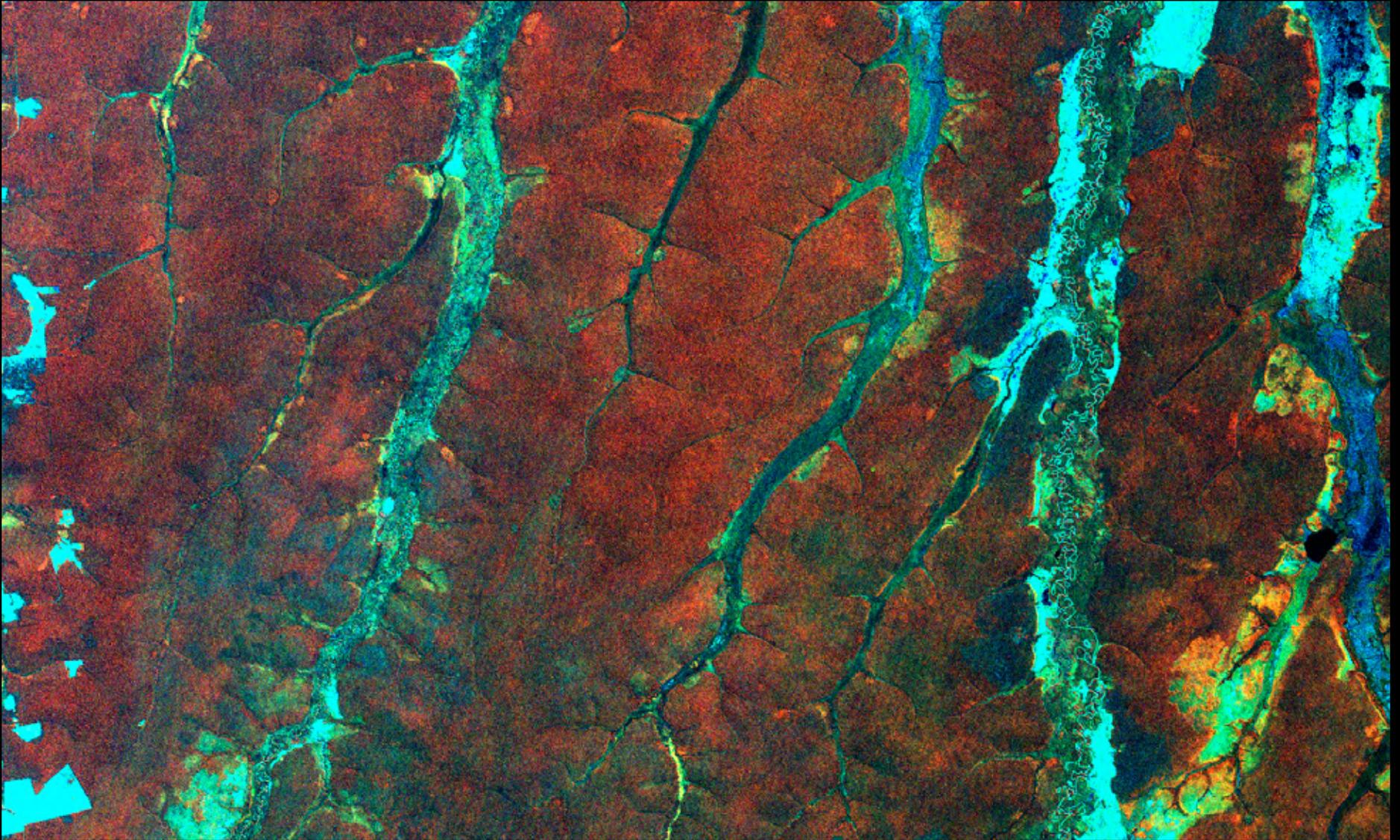
Reconstruction by Heather Hurst

1200 years later we can still see the effects of human activity upon the landscape. 80-90% of the landscape is a human artifact.

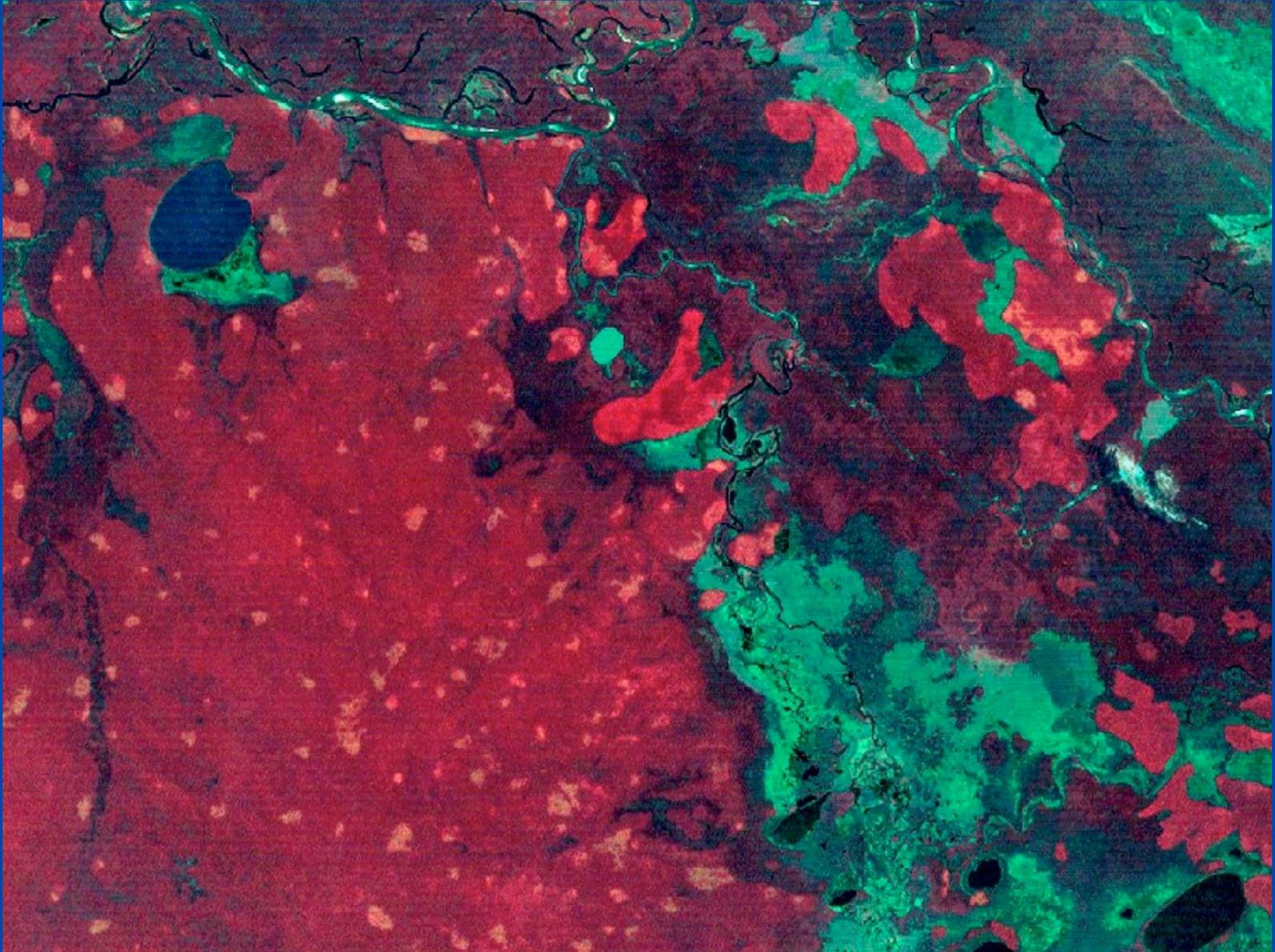


Amazon, Brazil

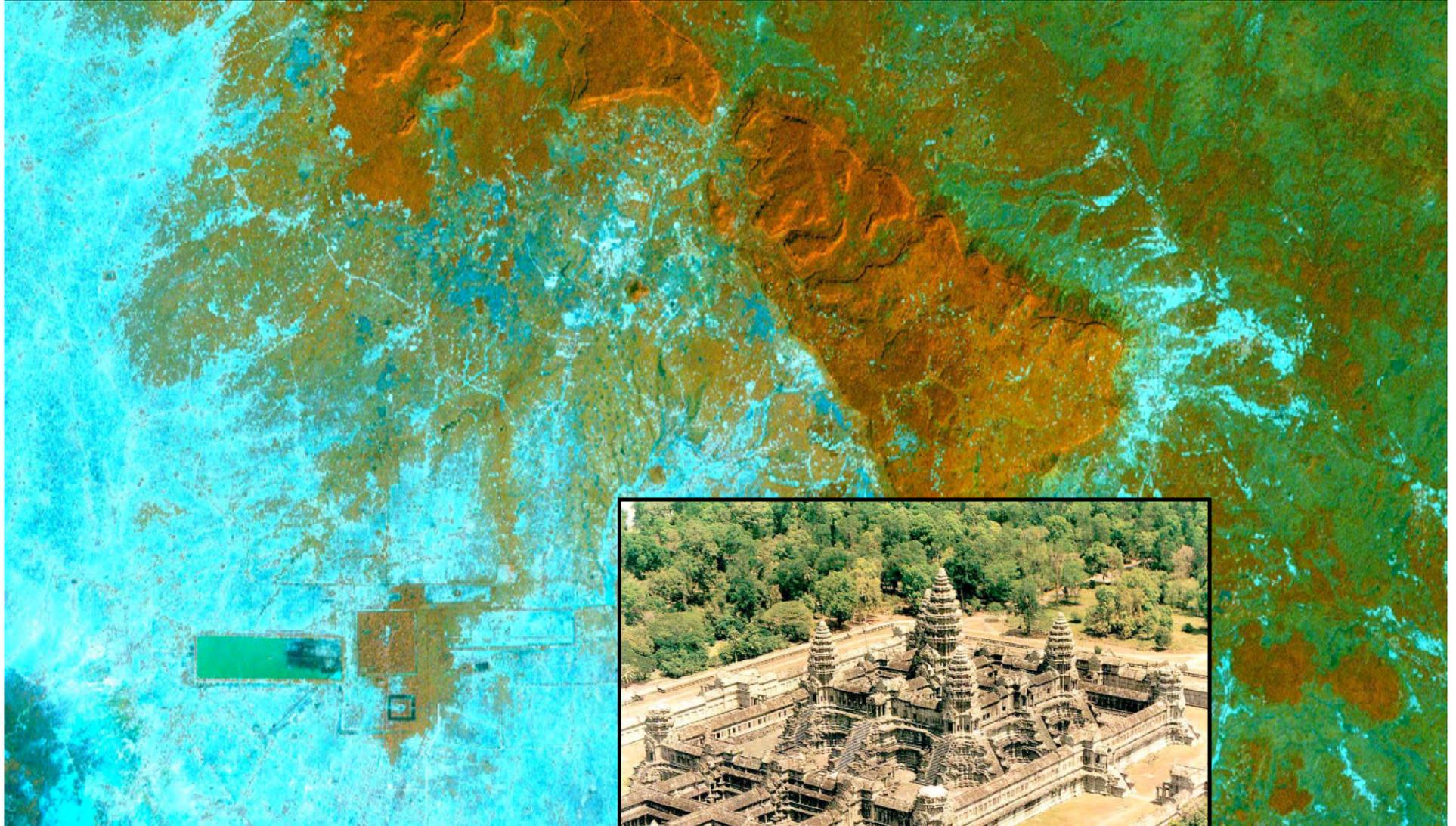
Pre-Columbian population: 54-112 Million; only 10% resided in North America



BOLIVIA

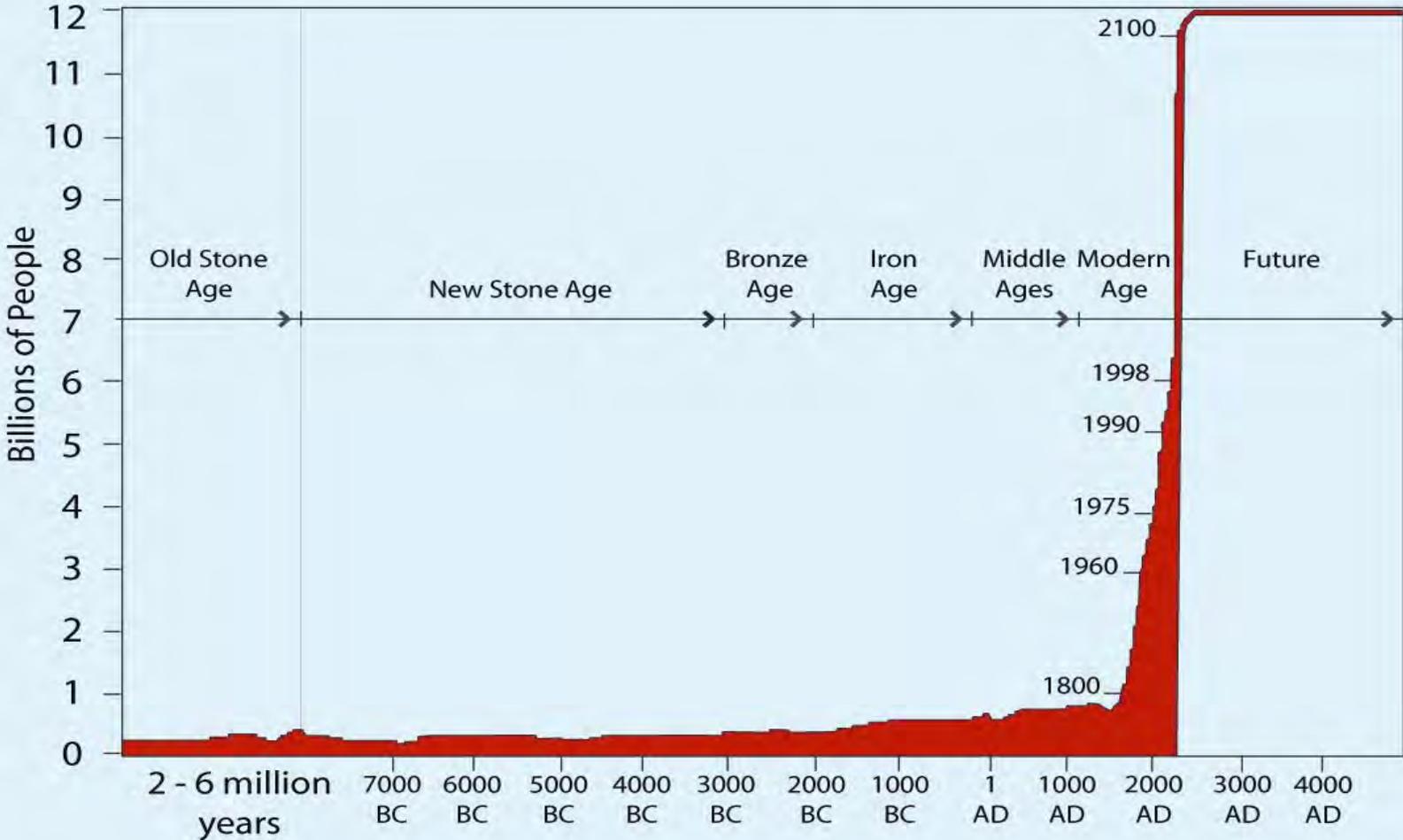


CAMBODIA (Khmer)



Angkor Wat

World Population Growth through History



SOURCE: "Population: A Lively Introduction," Joseph A. McFall, Jr., Population Bulletin, Volume 46, Number 2, October, 1991, pages 1-43, Population Reference Bureau, Washington, D.C.