24th Annual Meeting of UK-Belize Association (UKBA)
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'Climate Change and Biodiversity in Belize'

The Decay of maya Architecture at Lamanai and Other Sites . . . or

The Built Environment as Soil Parent Material

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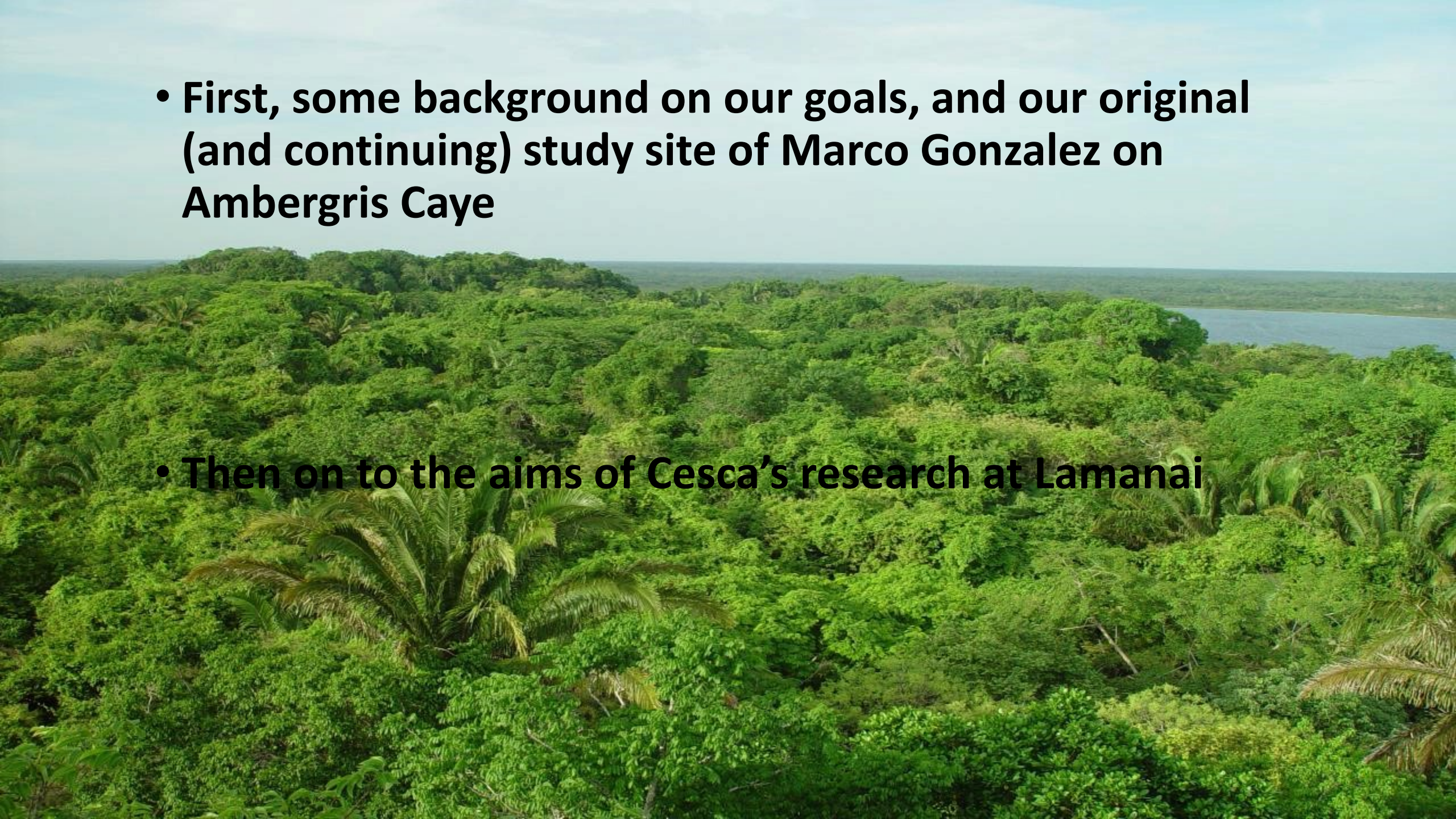


- First, some background on our goals, and our original (and continuing) study site of Marco Gonzalez on Ambergris Caye

- Then on to the aims of Cesca's research at Lamanai

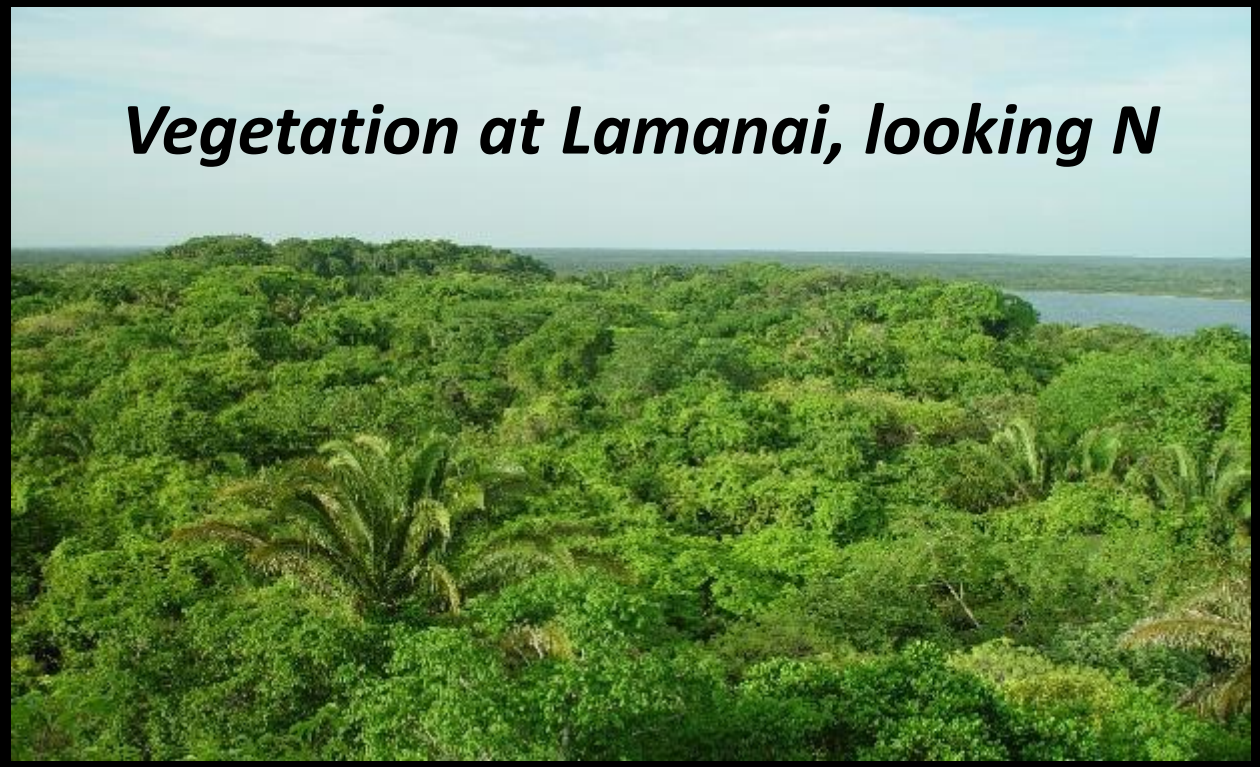
Kakalche, one of the Colson Point sites, looking east towards the Caribbean

Ceiba pentandra at Kakalc

Broadleaf forest vegetation in mangrove swan

What happens to what humans leave behind?

Study site at Marco Gonzalez, A.C.



Vegetation at Lamanai, looking N

Is present-day use of soils sustainable?

Evidence suggests that present-day use of soils is *not* sustainable.

Average global crop yields are progressively decreasing (Foley et al., p. 337)

Insufficient nutrients are an agronomic problem in many areas (p. 340)

The ability of many cereal crops to deliver full yields has fallen in the past 30 years.

Sources:

- Foley, J.A. et al. 2011. Solutions for a cultivated planet. *Nature* 478(7369): 337-348.
- *Annual Lancet Countdown on Health and Climate Change, 2019.*

What does archaeology have to contribute to soil security?

We, as archaeologists, are acutely aware of the fact that everything around us will eventually decay or disintegrate.

In the process, the products of decomposition contribute to the build-up of the earth around us. Shouldn't our knowledge and awareness be used to contribute to long-term environmental planning, particularly food security?

Overall research questions

How does the accumulation of archaeological deposits influence soil formation (availability and thickness) and the nutrient capacity of soils?

What are the long-term decompositional processes & how do they operate?

For Lamanai, in particular, the focus is mineral-based construction materials, which today are a major focus of interest regarding carbon emissions.

Main Aims at Lamanai

PAST: To understand long term human-environment interactions at Lamanai, focussing on the relationship between past urban land use and soils

PRESENT: To investigate the legacies of ancient Maya land use on present day soils and the ecosystem at Lamanai

FUTURE: To integrate archaeological and soil science research to address issues relating to soil health and sustainable land-use practices

Value of Soils

Societal & Environmental functions:

- nutrient cycling
- water cycling
- habitat provisioning
- carbon sequestration
- primary productivity

Ecosystem services:

- food production
- water quality
- climate control
- biodiversity

(Lehmann et al. 2020)

Soils in Urban Ecosystems

Urban Ecosystems:

- high density populations
- extensive built environment
- reciprocal flows and influences between city and hinterland

(Picket et al. 2001: 129)

Urban soils and sediments:

- heavily influenced by human activity and addition of materials

(Lehmann and Stahr 2007: 248-249)

Land Use in Urban Settings

Types of land use: civic/administrative, residential, production, transport, waste disposal, cultivation etc.

Examples of land-use practices impacting soils:

- incorporation of anthropic materials
- sealing & burial by fill material
- compaction
- fertilisation & irrigation
- removal/burning of vegetation

WHY STUDY SOILS IN ANCIENT MAYA CITIES?

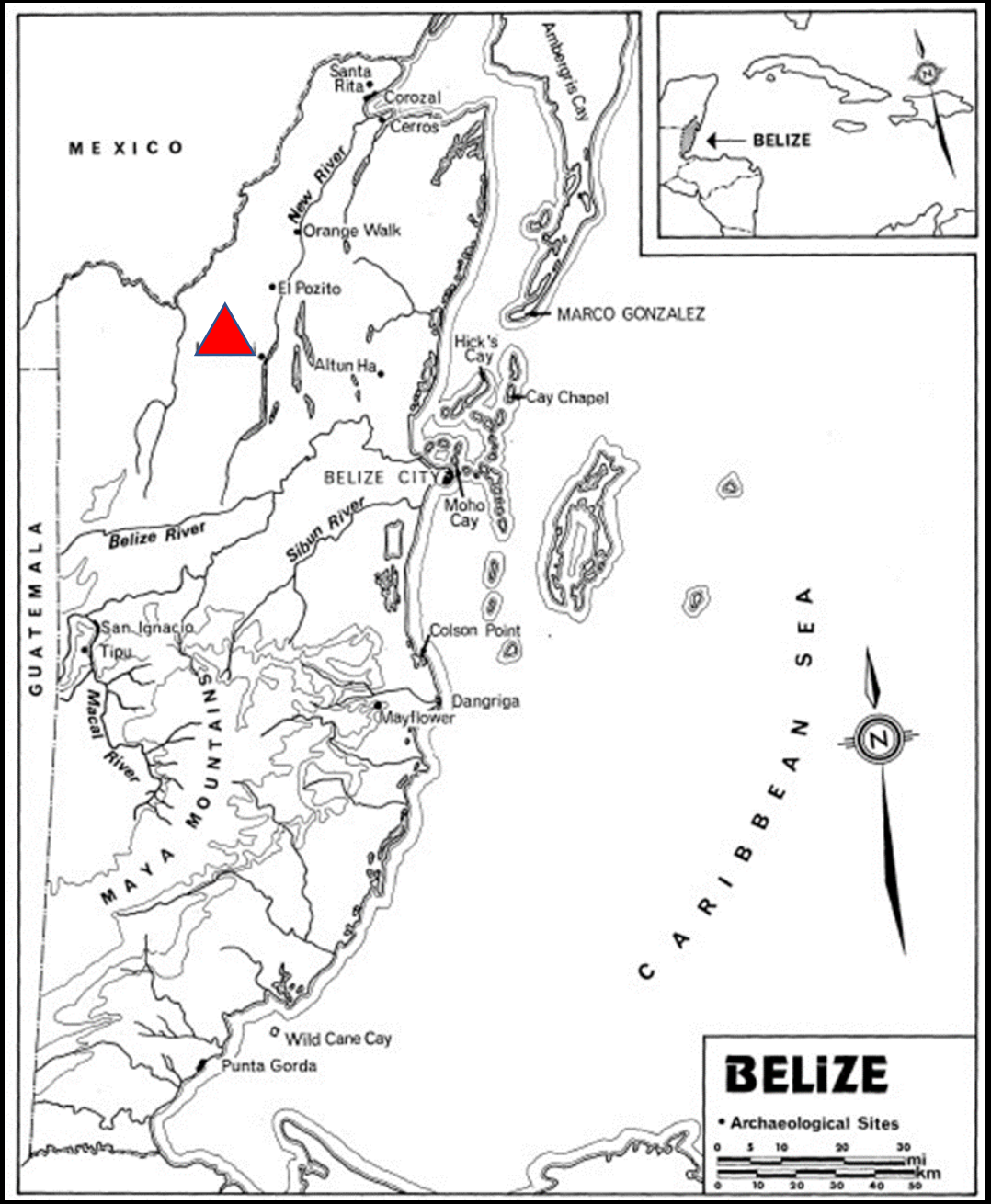
Maya Urbanism

- ‘Agro-urban’ landscapes & ‘green cities'
- Urban functions interspersed with agricultural production
- Land use patterns suggest planning to preserve and enhance soil properties

(Evans et al. 2021, Graham 1999, Graham and Isendahl 2018)

Why Lamanai?

- Extensive excavations and research since 1970s
- Long occupation and land-use history from ca. 1600 B.C. to the time the site was made a reserve in A.D. 1990
- Reached urban proportions for much of its history



Land-Use Change in Context

Remained occupied throughout the so-called 'Maya collapse'

But changes in settlement dynamics, natural resource exploitation, construction materials, cultivation practices…

Ideal case study to investigate:

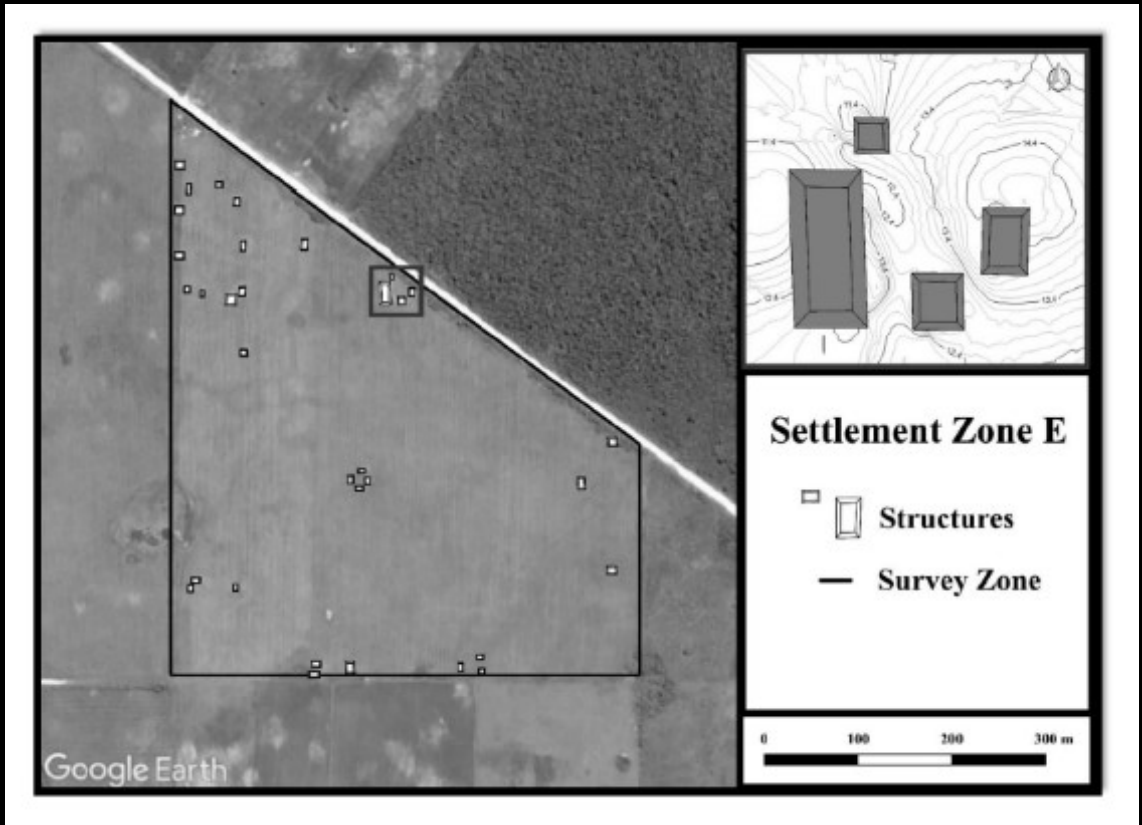
- process of urbanism & associated land-use change
- interactions with soils within broader context of socio-political and environmental change

Land Use in Civic-Ceremonial Centre

Jaguar Temple, Lamanai [Photo: Liz Graham]

- monumental buildings
- raised platforms
- residential compounds
- plazas
- causeways

Land Use in Peri-Urban Area



- farmsteads with multiple buildings
- activity areas - kitchens, latrines, rubbish disposal, gardens

[Images: McLellan 2020]

Research Questions

How did land use and the built vs open environment change over time?

In what socio-economic and environmental contexts did these changes occur?

How did different land uses affect the properties of soils?

What are the long-term effects of past urban land use on soil development?

How might this knowledge be used to inform discussions relating to soil health and sustainable land use practices in cities?

Planned Fieldwork

- Excavation of test pits along transects on urban to peri-urban gradient
- Located to represent different types of land use and different time periods

Planned Methods

- Soil profiles analysed for their physical and chemical properties
- Geoarchaeological & soil science methods

To determine:

- Nature of past land use and environment
- Resources, materials & impact associated with different land uses
- Characterise urban land-use change
- Formation processes and properties of soils today

Project Researchers: (in addition to E. Graham & F. Glanville-Wallis)

- Julia Stegemann – UCL Dept. of Civil, Environmental and Geomatic Engineering
- Richard Macphail – UCL Geoarchaeology
- Simon Turner – UCL Geography, palaeolimnology and studies of contaminants
- Mark Pawlett – Cranfield University, soil ecology
- Daniel Evans – Cranfield University, soil science
- Richart Whittet and Cristina Rosique – formerly of Royal Botanic Garden, and U. Edinburgh, biodiversity and vegetation
- Manuel Arroyo-Kalin – UCL Archaeology – Amazonian Dark Earth research
- Lindsay Duncan – environmental impact (Life Cycle Analysis, MFA, macrobotany [non-woody plants)
- Lydie Dussol –Université Côtes D'Azur, macrobotany (wood)
- Carmen Ting – Cambridge University, ceramic petrography
- Eva Jobbová – UCD, archaeology

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