

Institution: University of Exeter		
Unit of Assessment: UoA 15 Archaeology		
Title of case study: Revitalising Ancient Forest Practices in the Amazon for Sustainable, Biodiversity-Friendly Futures		
Period when the underpinning research was undertaken: 2007-2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name: José Iriarte	Role (e.g. job title): Professor of Archaeology	Period employed by submitting HEI: 2005 - present
Period when the claimed impact occurred: 2014-2020		
Is this case study continued from a case study submitted in 2014? No		
1. Summary of the impact		
<p>The Amazon rainforest is facing a crisis. Commercial interests, population growth, climate change and reduced environmental regulations are threatening biodiversity, indigenous heritage and community identity. Professor Iriarte's research has generated a long-term baseline for assessing these transformations. By facilitating and incentivising sustainable Amazonian land use, Iriarte's research has benefited marginalised communities in Bolivia and Brazil, through to the Brazilian government's environmental institution, ICMBio, with the following impacts:</p> <p>Developing and incentivising sustainable land use in Amazonian extractive reserves. These reserves are managed by national and regional authorities for activities such as Brazil nut and organic rubber harvesting and the sale of carbon credits to global markets.</p> <p>Rekindling bio-cultural identity within local communities, who now utilise their natural and cultural resources to generate crucial new revenue streams.</p> <p>Empowering women and young people within traditional communities to lead new bio-cultural tourism programmes.</p> <p>New creative outputs and raising public awareness of traditional Amazonian people's territorial claims via a series of media features, including a three-part documentary aired by Channel 4 (>2m viewers) and Discovery Channel, US.</p>		
2. Underpinning research		
<p>The protection of rainforests and the development of sustainable land-use practices are of global significance, vital for meeting the UN's Sustainable Development Goals. However, commercial interests, population growth, climate change and reduced environmental regulation are threatening Amazonian biodiversity and culture. Iriarte's research has generated a deep-time baseline for assessing these transformations. With support from a range of funders (Wenner-Gren Foundation, National Geographic, AHRC-FAPESP, ERC and GCRF) he has been exploring and documenting the rich cultural and environmental history of the Amazon forests.</p> <p>Through his AHRC-FAPESP project (2014-17), Iriarte and his research team demonstrated that the spread of <i>Araucaria</i> forests during the late Holocene in the southern Brazilian highlands was not the result of climate change, but rather deliberate afforestation by pre-Columbian groups belonging to the Jê culture [3.1]. The discovery that past human impact has had a lasting legacy on modern forest composition was developed further by Iriarte's concurrent ERC PAST project (2014-2018) [3.2-3.6]. PAST integrated data from archaeology,</p>		

paleoecology, archaeobotany, soil science, remote sensing and palaeoclimatology for several regions of the Amazon forest. This confirmed that native populations did not passively adapt to the forest, but rather transformed it to varying degrees. Specifically, for at least the past four millennia, communities practised soil fertilisation, closed-canopy forest enrichment, limited clearing for crop cultivation and low-severity fire management [3.2-3.4]. Through this, communities were able to attain long-term food security and nutritional diversity that was resilient to climate change and broad social upheaval [3.4-3.5]. Furthermore, this land-use system supported larger populations than are present in the forest today. These millennial-scale polyculture agroforestry systems have endured to the present in the form of highly fertile soil patches and legacy plots of palm, chocolate and Brazil-nut trees. These systems not only provide evidence of successful, sustainable subsistence strategies, but also highlight the forest's rich bio-cultural heritage [3.4].



Obtaining accurate information on the spatial distribution of the tropical forests' structure and composition is essential for conservation planning and the development of sustainable management practices. This is particularly the case for Brazilian Extractive Reserves, protected areas established by the Brazilian government to preserve the bio-cultural heritage of the Amazon. The reserves are inhabited by traditional populations whose livelihoods are primarily based on the extraction of non-timber forest products (NTFP), small-scale fisheries, subsistence agriculture and small animal breeding. Iriarte began working with the authorities (ICMBio) and traditional communities of the Cazumbá-Iracema Extractive Reserve (CIER) as part of his ERC Proof of Concept

FUTURES project (2017-18). This partnered with the Brazilian National Institute for Space Research and utilised novel Lidar light detection technology (conceived during Iriarte's PAST project) to create:

- i. Detailed digital elevation models of the reserve to design flood mitigation strategies and route planning (easier access to emergency services, schools, local markets).
- ii. 3D maps of the forest structure to identify new areas for the exploitation of NTFP (e.g. açai berries) that can be harvested for commercial markets via the village cooperative.
- iii. A carbon map of the reserve that precisely quantifies the carbon stored in the forest, which can be translated to carbon credits. Carbon credits are one crucial tool to address climate change by giving monetary value to activities that reduce or prevent the harmful greenhouse gases that contribute to climate change, such as deforestation.

This research was undertaken collaboratively with the communities of the CIER. During three days of workshops, CIER individuals worked alongside ICMBio managers to select the survey transects. They were later involved in the ground-truthing of the results. During the same period, participatory research was also undertaken via the PAST project, in which the Itonama Indigenous Community of Versailles in Bolivia (VIIC) were involved in two archaeological field seasons (2017-18).

In March 2019, Iriarte undertook a five-day workshop with the VIIC, funded by GCRF. It was designed to connect the VIIC with its forgotten heritage, link the modern forest and crop production to past forest enrichment, and demonstrate the economic value of this heritage through the development of pathways for cultural and environmental bio-cultural ecotourism. The workshops were facilitated by Zulema Lehm (a gender specialist anthropologist) of Wildlife Conservation Society to ensure that female and male perspectives, experiences and challenges were equally documented.

3. References to the research

[3.1] Robinson, M., J. G. De Souza, S. Y. Maezumi, M. Cárdenas, L. Pessenda, K. Prufer, R. Corteletti, D. Scunderlick, F. E. Mayle, P. De Blasis and J. Iriarte. 2018:

'Uncoupling Human and Climate Drivers of Late Holocene Vegetation Change in Southern Brazil' Scientific reports 8, 7800. DOI: 10.1038/s41598-018-24429-5.

[3.2] Iriarte, J., Elliott, S., Maezumi, S.Y., Alves, D., Gonda, R., Robinson, M., de Souza, J.G., Watling, J., Handley, J., 2020. The origins of Amazonian landscapes: plant cultivation, domestication and the spread of food production in tropical South America. *Quaternary Science Reviews* 248: 106582. DOI: 10.1016/j.quascirev.2020.106582.

[3.3] Maezumi, S.Y., Alves, D., Robinson, M., de Souza, J.G., Levis, C., Barnett, R.L., de Oliveira, E.A., Urrego, D., Schaan, D. and Iriarte, J. (2018): 'The legacy of 4,500 years of polyculture agroforestry in the eastern Amazon'. *Nature Plants* 4:540-547. DOI: 10.1038/s41477-018-0205-y.

[3.4] Iriarte, J. 2017: 'Un futuro sostenible para la Amazonia: lecciones de la arqueología' (A sustainable future for the Amazon: lessons of archaeology), in: *Exploring Frameworks for Tropical Forest Conservation: Managing Production and Consumption for Sustainability*. UNESCO, 140–161. <https://unesdoc.unesco.org/ark:/48223/pf0000265651>.

[3.5] De Souza, J.G., Robinson, M., Maezumi, S.Y., Capriles, J., Hoggarth, J.A., Lombardo, U., Novello, V.F., Apaéstegui, J., Whitney, B., Urrego, D., Alves, D., Rostain, S., Power, M., Mayle, F., Cruz Jr, F., Hooghiemstra, H., and Iriarte, J. 2019: 'Climate change and cultural resilience in late pre-Columbian Amazonia'. *Nature Ecology & Evolution* 3 1007-1017. DOI: 10.1038/s41559-019-0924-0.

[3.6] DeSouza, J.G., D. Schaan, M. Robinson, A. Barbosa, L. Aragão, B.H. Marimon Jr, B.S. Marimon, I Silva, S. Khan, F. Nakahara, and J. Iriarte. 2018: 'Pre-Columbian earth-builders settled along the entire southern rim of the Amazon'. *Nature Communications* 9, 1125. DOI: 10.1038/s41467-018-03510-7.

4. Details of the impact

Amazonian tropical forests play a key role in local, regional and global ecosystem services. They are the largest reservoir of biodiversity on the planet and are of crucial importance for the regulation of Earth's climate. The forests also offer rich supplies of raw materials such as food, medicine and timber – resources from which more than 90% of the world's poorest people earn their livelihoods. And it is predicted that, by 2050, 50% of the global population will live in the tropics (*State of the Tropics 2050*).

Following a decade of stability (2005-2015), Amazonian deforestation is again on the rise, with global demand for soybeans and beef increasing, governmental institutions weakened, and environmental regulations loosened across the region. Traditional communities in the Amazon are rapidly converting to cattle ranching and commercial slash-and-burn agriculture due to the lack of alternative economic pathways. This is not only causing deforestation, but also denuding community identity and marginalising women, who are excluded from such commercial activities. Iriarte's research has been leveraged to address these issues, with the following impacts:

Developing and incentivising sustainable land use

The Lidar data generated through the PAST and FUTUREs projects show that the CIER forest, which roughly covers the size of Devon (7,500 km²), preserves ~106,000 tonnes of carbon (Mg C). This represents 0.11 carbon stocks (Pg C) – equivalent to 5,145 tanker trucks of gasoline **[5.1]**. This precise calculation of carbon stocks has been used in the negotiations to define the amount paid as environmental service by French footwear brand Vert, which buys organic, sustainably collected rubber from the CIER. Vert stated: "*The three-dimensional mapping of the forest and the precise calculation of carbon stocks of the reserve will be used (...) to allow us to monitor deforestation accurately. This is critical because we do not pay the premium price for rubber if deforestation is detected in the vicinity*" **[5.2]**.

The 3D map of the forest, and the development of an algorithm to identify new concentrations of non-timber forest products (NTFP), have identified two new clear concentrations of açai palms and three Brazil nut, which will enable the CIER to expand the production of açai berry juice as well as creating a Brazil nut processing plant **[5.1, 5.3, 5.4]**. In addition, the Lidar data have (i) helped demarcate and open least-cost trails (eg. those that avoid streams and swamps) for the

collection and extraction of açai palm berries, Brazil nut and rubber, as well as for tourism and biodiversity monitoring; (ii) identified potential areas for the installation of lakes for fish farming; (iii) provided guidance for installing forest plots for biological research; and (iv) assisted the design of flood mitigation strategies and route planning (easier access to emergency services, schools, local markets) [5.1, 5.4]. CIER testimony says the research allowed them “to plan with confidence” the expansion of their açai processing plant and the creation of a new one for Brazil nuts. The Lidar data have also been instrumental in Vert’s environmental programme. Families that participate in projects with Vert obtain on average 28% more annual income than other families in the same region. There are 40 CIER families participating [5.2]. Together, these factors represent important sources of household income for the CIER residents [5.2, 5.4].

“Knowing precisely the natural resources we are protecting and the carbon they store has given us the basis to negotiate with the VERT foot-wear company the environmental services of the organic rubber that we collect in the reserve and knowing the exact amount of carbon that our forests stores put us in a privileged position to obtain carbon credits.” – CIER testimony [5.4]

Rekindling bio-cultural identity

Heritage did not feature in the landscape or thoughts of the 33 families of the Itonama Indigenous Community of Versailles (VIIC). Archaeological features were ignored, large prehistoric urns were used as rubbish bins, and the villagers were unaware that the highly fertile black soils on which they grow their crops were a remnant of thousands of years of forest enrichment by past communities. Before the collaboration, demand for economic growth had placed pressure on natural resources, with discussions increasingly turning to the economic potential of cattle ranching and commercial slash-and-burn agriculture. Collaboration through the PAST project, and in particular the GCRF-funded workshops, have developed alternative pathways for cultural and environmental heritage ecotourism [5.5]. Collectively, they laid the foundation for an internal reassessment of community governance and the creation of a development strategy for the community to take charge of their natural resources to equitably and sustainably exploit their environmental and cultural heritage.

Cultural historical maps, produced in collaboration with the village, contribute to the social valuation of indigenous history, incorporating archaeological features that were once passed unnoticed, as the community appropriates heritage and archaeological knowledge [5.6]. The identification of aspects of heritage within the landscape, coupled with the production of a bilingual website containing cultural and environmental heritage brochures and videos in English and Spanish, has changed the local perception of landscape and identity and provided the tools to create a heritage experience for visitors [5.6, 5.7]. Since the collaboration began in 2017, the community has begun welcoming cultural heritage tourists, which has created a new stream of revenue. Secondary commercial opportunities, selling goods and services to visitors, have further created economic opportunities [5.5, 5.6, 5.7, 5.8].

Feedback from the VIIC states that the research has allowed the community to bring together all their knowledge of the flora, fauna and history in the tourist guides:

“For example, although we know the common names of most of the fish in the region, we now have guides with photos, scientific names and their habits. This is something very appreciated by tourists who come from big cities and for which we had no answer before. (...) Very importantly, the arrival of tourists to the community has given us a new income by hiring guides, renting rooms in our hostel and preparing meals with food from our gardens.” [5.6]

Empowering women and young people

The VIIC had been economically dependent on activities undertaken by men (Brazil nut harvesting and fishing guides) while the unpaid female roles of managing homes, garden plots and family nutrition were marginalised. By stressing the value, heritage and biodiversity represented by Amazonian plant cultivation, the research has raised the profile of women as vital caretakers of this global asset. This recognition has begun to address gender inequalities

and enabled pathways for female-generated income [5.7, 5.8]. A legacy of the Jê Landscapes project (AHRC-FAPESP, Wenner-Gren) is that former Brazilian PhD students on the project are now professors of anthropology at the Federal University of Pelotas and they have created an anthropology graduate programme with the participation of the first Jê indigenous students in southern Brazil [5.9]. This significant step will help empower indigenous peoples, as well as protect, preserve and develop traditional skills and culture. Meanwhile, open days, workshops and school talks disseminate the knowledge of this project into local communities.

Raising public awareness of territorial claims and new creative outputs

The findings of the PAST project have been showcased in high-profile international media, including *The Guardian*, *The Guardian (US)* (>26k shares), *New Scientist*, *National Geographic* (>100k visitors), *The Wall Street Journal* and a podcast on *Scientific American* [5.10]. This has helped raise awareness of the role of indigenous people in shaping and preserving the Amazon forest. Three case studies from research carried out in the context of the PAST project [3.2-3.6] form part of a three-part television series *Jungle Mystery: Lost Kingdoms of the Amazon* released on Channel 4, UK (December 2020, >2m viewers) and on Discovery Channel, US, 2020 [5.11a, 5.11b]. As Series Consultant for the programme [5.11c], Iriarte helped shape and verify the contents of the series, which focuses on the role that archaeological evidence plays in the reclamation of threatened indigenous territorial rights.

5. Sources to corroborate the impact

[5.1] Report: 'Mapping forest structure of the Cazumbá-Iracema Reserve with airborne LiDAR', approved by INPE. The following products were co-produced with CIER: (a) Digital Terrain Model of CIER showing new emergency circulation routes (pp. 3-4, Figure 3); b) estimation of carbon stocks of CIER (pp. 12-14) and c) 3D map of forest structure showing concentrations of NTFPs Brazil nut (p.7) and açai (pp.8-9) for CIER cooperative.

[5.2] Letter from the Head of Sourcing, Vert/Veja footwear company;

[5.3] Letter from the Head of Conservation Unit, Cazumbá-Iracema Extractive Reserve, Acre state, Brazil, ICMBio, Ministry of Agriculture (Portuguese language). ;

[5.4] Testimonial from the CIER community (Portuguese language).

[5.5] Diagnosis and plan for the Versalles Community: 'Diagnóstico y plan de la comunidad de Versalles'. Available on request (Spanish language).

[5.6] Letter from the Mayor Versalles Community (VIIC) (Spanish language).

[5.7] Cultural and environmental websites created by the project: (a)

Spanish: <https://comunidadversalles.wordpress.com/>; English:

<https://versallescommunity.wordpress.com/>; (b) cultural and biological heritage guides (English

and Spanish) created by University of Bonn, WCS Bolivia, and University of Exeter; (c)

Versalles Community Mammal Identification, Historical and Cultural Guide of the Community

of Versalles, Fishes of the Itenez River (in Spanish and English); (d) Video: 'Versalles Paraiso

de la Amazonia' (Spanish) <https://www.youtube.com/watch?v=QIVgtROI7HQ>.

[5.8] Letter from the Director, Wildlife Conservation Society.

[5.9] Dr Rafael Millheira and Dr Rafael Corteletti (former PhD students

on Jê Landscapes project) helped create an Anthropology

Graduate Programme <https://wp.ufpel.edu.br/ppgant> which offers scholarships to students with

an indigenous background through the government affirmative

action programme <https://wp.ufpel.edu.br/naaf/sobre/>.

[5.10] Media coverage: (a) *The Guardian*, 27.03.18, cites [3.6]; (b) *The Guardian (US edition)*,

29.11.20 (>26k shares at 31.12.20); (c) *Guardian Editorial*, 4.12.20; (d) *New Scientist*,

16.01.19; (e) *National Geographic*, 27.03.2018, cites [3.6] (>100k visitors to the article); (f) *Wall*

Street Journal, 27.03.18; (g) Podcast: 'Humans and the Amazon: A 13,000-Year Coexistence',

Science Talk, *Scientific American*, 20.03.2015.

[5.11] Television programme 'Jungle Mystery: Lost Kingdoms of the Amazon': (a) Confirmation

from Wild Blue Media of research content used; (b) Channel 4 viewing figures (total

for 3 episodes: 2,399,000); (c) Credits: Iriarte named as Series Consultant.