Paleoriverine Features of the Amazon Lowlands: Human Use of the ‘Arena Negra’ Soils of Lake Charo, Northeastern Peru

OLIVER T. COOMES

5.1 Introduction

Amazonia has long been divided by observers into two distinct environments - the upland (or terra firme) and the lowlands (or várzea) - a distinction that pervades the literature on subjects ranging from prehistory, archaeology, and Amerindian cultures to biological diversity, natural resource use, and agricultural development. The upland environment, lying above the floodplain of the Amazon River and its tributaries, offers a stable substrate, old forests, sparse pasture and soils of limited agricultural potential. In contrast, the lowland environment is highly dynamic and unstable, with young forests, abundant aquatic fauna, and nutrient-rich alluvium. Such depictions, however, are challenged by a growing body of research that points to high soil heterogeneity on the uplands (and some of high native fertility), the extensive occurrence of anthrosols - terra preta soils - on the Brazilian uplands (see chapters in this book; Lehmann et al. 2004), and the recognition of paleoriverine landforms that lie beyond the active floodplain of Amazonian rivers, but below the upland (Salo et al. 1986; Pahakka et al. 1992). Whereas terra preta soils appear to be frequently encountered along major river courses and in many interfluvial areas of the Brazilian Amazon, far fewer terra preta sites have been identified in the Upper Amazon and such sites tend to be found on river bluffs.

In this chapter, I suggest that paleoriverine features in the Amazon Basin are worthy of closer study, as potentially important sites of prehistoric agriculture and of significant potential for agricultural development. The paucity of terra preta sites in Upper Amazonia is perhaps not surprising given the proportionally large area of lowland and the dyanism of the Andean rivers that are continually reworking their floodplains (viz. Lathrap 1968, 1970). Nonetheless, extensive areas do exist in the lowland of paleo-floodplains. Salo et al. (1986) estimate that previous floodplains occupy about 75,100 km² or 14.6% of the area of Peruvian lowland forest. Abandoned floodplains - marked by paleomounds, abandoned channels, scroll-bar complexes, islands, and levees - are found not only along the Ucayali, Marañón, and Amazon rivers, but also in association with tributaries such as the Pastaza.

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Tigre, and Tapiche Rivers (see Puhakka et al. 1992; Piirsnõm et al. 1996). Paleoverterine landforms would seem ideally suited for agricultural production – combining the higher fertility of lowland alluvial soils with relative security from frequent floods – and, if located near upland bluffs (la Denevan 1996), are likely to have been extensively used by farmers in prehistory. For modern farmers, access to markets is also critical and paleoverterine features near rivers (or roads) that link producers with proximate urban centres offer high promise for market-oriented agriculture.

The case for closer attention to paleoverterine features in Amazonia is illustrated here through a study of a paleomeander island that lies within the Amazon River valley but above the meander belt floodplain and beyond the reach of decadal floods, near Lake Charo in northeastern Peru. Local residents refer to the site as the ‘yurisalas’, after the presence of the ivory nut or yurina palm (Phytelephas macrocarpa). The soils of the yurisalas – dark-brown, fertile sandy loams – are distinct from those of both the Amazon River floodplain and the Tertiary upland. Since the late nineteenth century, farmers have practiced on the site one of the most productive and profitable forms of lowland swidden-fallow agroforestry yet described for the Amazon Basin. The following account of site characteristics and human uses of this paleo-island is based upon field information gathered between 1989 and 2000, during multiple visits to the area.1

5.2 Site Location and Characteristics

The paleomeander island is located at 4°15'S 73°15'W, near Lake Charo, about 65 km due south of the city of Iquitos in northeastern Peru (Fig. 5.1). At this point, the Amazon Valley spans a distance of about 20 km, with the Amazon River flowing along the western margin and its active floodplain dissected by recent scroll bars, inter-bar lakes, and streams. To the east, at slightly higher elevations, is a low floodplain terrace upon which the Tahuayo River flows, joining the Amazon River downstream, and we find the paleomeander island (see Räisänen et al. 1998). The island takes the form of a shield comprised of

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1 In 1989, I and my assistants conducted a detailed household survey in each of the 16 communities and two colonies in the basin, including the villages that use lands on the yurisalas, to assess economic livelihood and market specialization in agriculture and natural resource use (see Coomes 1993b, 1998). The following year, we undertook field visits to the yurisalas, collecting soil sampler and assessing selected fields and orchards for cropping/following history, crop choice and density and area. Records from boats transporting produce from the Tahuayo to Iquitos were gathered and used to assess the seasonality of production by villages along the river. In 1994, we returned to interview residents of the community of Iquitos – under which the primary jurisdiction of the paleomeander island falls – with respect to land holdings, avacado production, and non-agricultural uses we visited the paleo-island once again with local authorities, discussed the history of land use, and dug test soil pits for description. In our last visit during 2000, we re-interviewed avocado producers in Iquitos and estimated production, assessed prices and costs, tree losses, and tree planting.
low ridge-and-swale topography which covers a total area of about 635 ha and is raised above the surrounding lowland by about 2.5–4.0 m. Not subject to annual flooding, the highest lands of the site would seem to have been only rarely flooded over the past 100 years, if at all. The seral stage of tree species found on the site include ojî (Vicus spp.), igupuna (Cedra pentandra), huinba (Cedra samauma), and quinilla (Pouteria spp.). To the south, the oxbow lake
of Charo occupies an abandoned river channel of a meander that once embraced the island. The genesis of the island is likely to resemble that described by Mertes et al. (1996) for scrob-bar complex development in the Brazilian Amazon.

The soils of the paleo-island complex are distinct from soils encountered on either the upland or the lowland. The dark brown, sandy loams of the yarinãs – referred to by local farmers as 'arenas negras' – are considered to be particularly fertile. A hand-dug profile to 126 cm below the surface finds the organic layer (0-23 cm) and brown sandy loam (25-58 cm); with increasing depth we observe reduced organic matter, decreased darkness, and increased portion of mica-rich sand to a sandy base. The physicochemical characteristics of the yarinãs soils (0-15 cm) are distinct, as indicated by soil samples taken on the nearby upland (Ultisols) and along the white-water Amazon River floodplain (Fluvvents) (see Table 5.1). The yarinãs soils are high in sand content and low in both silt and clay. The lack of flooding appears to have enabled soil formation and structural development. Chemically, the pH is higher than the upland, but lower than soils of the Amazon floodplain. Organic matter content is not distinct. Of the nutrients, phosphorous stands out as being significantly higher – suggestive of past human occupation and indicative of the higher fertility of the soils on this 'perched' island (Fig. 5.2). In areas inundated annually, a clay cap (about

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Meander Island</th>
<th>Amazon River floodplain</th>
<th>Tertiary upland</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>5.7</td>
<td>7.3</td>
<td>4.0</td>
</tr>
<tr>
<td>Organic matter (%)</td>
<td>3.16</td>
<td>2.07</td>
<td>4.33</td>
</tr>
<tr>
<td>Phosphorus (ppm)</td>
<td>29.7</td>
<td>0.3</td>
<td>5.7</td>
</tr>
<tr>
<td>Potassium (ppm)</td>
<td>50</td>
<td>103</td>
<td>48</td>
</tr>
<tr>
<td>Calcium (ppm)</td>
<td>1,380</td>
<td>2,945</td>
<td>63</td>
</tr>
<tr>
<td>Magnesium (ppm)</td>
<td>177</td>
<td>266</td>
<td>30</td>
</tr>
<tr>
<td>Sand (%)</td>
<td>84</td>
<td>17</td>
<td>51</td>
</tr>
<tr>
<td>Silt (%)</td>
<td>19</td>
<td>66</td>
<td>34</td>
</tr>
<tr>
<td>Clay (%)</td>
<td>2</td>
<td>17</td>
<td>14</td>
</tr>
<tr>
<td>Number of samples</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>
50 cm thick) covers the land surface and soil properties are similar to that of
the Tahuayo River floodplain (Gley soils).

Seven villages are located in the vicinity of Lake Ch'aro, ranging in distance
from 1-11 km to the paleomanser island. Historically, lands in the yarinales
have belonged to residents of Esperanza, the largest and oldest of the com-
munities in the region, about 7 km (or 1 h by canoe) downstream of the site
on the Tahuayo River. Residents of Esperanza as well as the other villages
have long cultivated agricultural fields on the yarinales, hunted game,
extracted non-timber forest products, and collected medicinal plants from
the forest. Lake Ch'aro is also a site of an important local fishery, particularly
as river levels fall in June and July.

5.3
Early Use of the Yarinales

Although not known to archaeologists as a site of prehistoric occupation, the
location, site characteristics, and presence of material artefacts (potshearts
and stone implements) all suggest the presence of humans during prehistory.
Islands in the Amazon River are known to have been intensively cultivated in
prehistory, especially between Iquitos and Peru, but perhaps also upstream.
As the meander was cut-off and abandoned, the secluded higher ground of
the island near an oxbow lake would have been an attractive site - providing
early residents with an abundant supply of fish, access to resources in the
nearby, palm-rich swamp forest as well as to the secure upland where they could take refuge during exceptionally high floods. No reports are found in scholarly research on the location of Amerindian communities at contact in the region, nor is the area mentioned in early travel accounts despite its proximity to the mission of San Joaquin de Omaguas (founded in 1697) along the Amazon River. Some two dozen farmers with land on the yarinanes reported to us their finding artefacts, including painted and unpainted potsherds and stone implements, though most recovered material is of historic rather than prehistoric origin.

In historic times, the forests of the paleomeander island have been worked since at least 1877 when the upper Tahuayo River Basin was a focus of wild rubber production (Coomes 1995). A land survey conducted in 1912 of the rubber estate of "Actividad" (4,854 ha) – which encompassed the yarinanes – found 54 rubber trails (estradas), 200 ha of agricultural fields, and 60 ha of pasture. Rubber tappers lived in isolated huts along the trails, tapping latex from rubber trees (Hevea brasiliensis) and practicing swidden-fallow agriculture for subsistence. The early tappers are said to have introduced avocado (wira variety) to the area. During the post-boom period (1920s–1940s) residents of nearby Esperanza harvested large quantities of vegetable ivory (up to 10 mt/month) for sale to a button factory in Iquitos. In the mid-1940s, when the demand for tags fell with the advent of hard plastics and a brief revival of rubber ended with World War II, residents shifted their use increasingly to swidden-fallow agroforestry and began clearing the yarina palm for new fields. Such fields were opened only by the estate owners and their sons who introduced a larger variety of avocado (e.g., 20-cm, pullo grande) and set aside a low-lying area of the yarinanes as a reserve to conserve the supply of yarina palm fronds used for roof construction. Estate tenants were first allowed to hold fields in the yarinanes in the 1960s, and in 1974 the estate was formally dissolved by the Agrarian Reform, leaving the land to the "killers".

Today, the farmers who work the coveted lands of the yarinanes are descendants of the original estate owners, former estate peones, and tenants, as well as newcomers. Of mixed Iberian and Amerindian origins, these mestizo people (ribereños) rely on a mix of traditional agriculture, fishing, hunting, and forest product extraction for their livelihood (see Hirooka 1985; Padoc 1980; Chiminuk 1994). Surplus and speciality crops are sent to market by daily river boats, a journey of about 1 day downstream to Iquitos, the primary urban centre and market in northeastern Peru. All are economically poor, earning typically less than US$600/year in cash income and holding 5–10 ha of land and less than US$200 of non-land assets (Coomes 1992).

Although often described as highly egalitarian in terms of wealth (or pov-

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9 As reported in the Informe Sobre la Demananción del Pando and the Informe Pericia both of November 1912, as part of the application by Sr. Rafael Pindo Rio for title to the property "Actividad". Title granted on 2 November 1918 (no. 1068) and cancelled in 1974 by Resolución Directorial Zonal no. 163-DZ-A-VIII-74.
Pleistocene Features of the Amazon Lowlands

Contemporary Agriculture

Farmers practice three swidden-fallow cycles on this paleo-landform—defined by the dominant crop and relative elevation—(1) a manioc/maize cycle; (2) a plantain cycle; and (3) an avocado orchard cycle (Fig. 5.3). In low-lying areas where the depth of the annual flood is typically greater than 75 cm, farmers practice short cycle cultivation of manioc and/or maize. As floodwaters recede in May and June, farmers plant manioc and maize in these clayey soils and harvest before the flood returns in late December, leaving then the field in fallow for 2–3 years. Farmers will intercrop the maize and manioc with watermelon, yams, dale dale, peach tomato, vegetables (e.g., sweet potatoes, tomatoes), and papaya. In selected places, rice is monocropped. At higher elevations on the yarinas, farmers cultivate manioc/maize, followed by plantain (3–6 years), and a fallow of 3–4 years. Plantain can withstand only temporary inundation of its stem and so requires some-what higher land (i.e., <75 cm of floodwater). Interspersed among the plantain are yams, taro, bijao, papaya, and balsa wood. Yields of plantain here are reportedly double those on the upland. At elevations above floodwaters, where the soils are loamy, friable, and more fertile, farmers incorporate avocado, after manioc/maize and plantain, as the terminal tree crop, managing this cycle over a period of 25–60 years. Avocado orchard size ranges from 0.12–3.0 ha (median: 0.5 ha) with tree densities of 5–600 ind./ha (median: 70) and ages of 3–50 years (median: 25 years) (=35 orchards). Alternate terminal tree crops include cacao, mango, sour sop, sapote, star apple, breadfruit,

Fig. 5.3. Swidden-fallow agricultural cycles practiced on the paleomarsh island, Lake Chico, Peru.
macambo, arazá, and even citrus and umari; indeed, the only crops known not to grow well here are pineapple and cashew, both crops that prefer acidic soils. Only the fields of maize/manioc and of banana are visible from the air because the avocado orchards are surrounded by taller native trees that afford the orchards protection from windthrow (see Fig. 5.4).

Avocado is the 'signature' crop of the purínales, by far the most important cash crop to local farmers and well known to buyers in the markets ofiquitos. Ideally suited in the swidden-fallow agroforestry cycle, avocado fetches a good and relatively stable price ($US 10–15/100) and is rich in protein, serving as an important dietary supplement, especially among children. The tree has a long productive life and coppices easily – if the tree is blown over, farmers will cut the trunk and re-seat the base (which coppices forth a new tree) or leave the fallen bole which coppices from the ground, an important advantage over other potential tree crops. Its fruit is large and requires ripening, typically at home, before shipping to market; two features that reduce large-scale theft from these distant fields. The tree, however, is highly sensitive to water, perishing if flood waters reach its roots and vulnerable by its shallow root system in these sandy soils to windthrow. Paca prey on the seeds and a tree borer (geusano) cripples mature avocado.

Two varieties of avocado are produced – the smaller and finer, wire pulita and the thicker-skinned, pulita grande. The tree is raised from seedlings, collected from beneath mature avocado, and transplanted at distances of at least 5 m from one another so as to limit the need for the tree to grow tall. Under-
growth is left around the base of the tree in order to preserve soil moisture. Avocado here bears fruit first in the sixth year after planting and has a productive life of about 35–40 years, although we observed two trees that were reputedly 86 years old. Each tree will produce between 200 and 500 fruit/yr (palsa grande) and 400–700 fruit/yr (wira palsa) during two seasons—mid-April to the end of July and October to December. Although only a fraction of production is sold (i.e., the highest quality fruit), we estimate market production from the area during the 1990s to have been 75,000–200,000 fruit/yr from 40 producers, of whom 25 reside in Esperanza and harvest at least 80% of the total crop.

Avocado is both an important source of cash income for farmers and a vital economic asset. Our survey among Esperanza producers in 2000 found sales for the previous year of 350–26,000 fruit/household (mean: 5,100) for an estimated gross value of about US$15,000 (Table 5.2). Although the costs of harvesting and transportation are significant (about 30% of gross), households are left with substantial income, particularly when the incomes of large producers (US$1,000–5,000/year) are compared with the rural wage of US$1–2/day. Indeed, earlier survey data (1988–1989) from the same producers indicated that avocado sales contributed a significant amount of cash income to producing households in the community and both their incomes and total land holdings were significantly higher than non-producers. Production though is quite highly concentrated, with the top five producers harvesting just over one-half of the total crop (53%). The top producers are descendants of the community founders and whose families have lived well for as many as five generations from avocado, sending their children to iiquitos for schooling and, in good years, purchasing much of their food. Although parinales land per se is held only in usufruct (i.e., it cannot be bought or sold), individual avocado trees are sometimes purchased (US$10–15/tree) and households consider them as liquidable assets that can be passed on to their children. Again, better-off households have substantial orchards, ranging up to 75–115 trees, with larger holdings on the highest land.

Table 5.2. Avocado production in Esperanza, Tahuayo River, Peru, 1999–2000. Source: interviews with avocado producers (n=20)

<table>
<thead>
<tr>
<th></th>
<th>Palsa Grande</th>
<th>Wira Palsa</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated production (no. of avocados)</td>
<td>84,710</td>
<td>41,250</td>
<td>126,000</td>
</tr>
<tr>
<td>No. of avocado trees (no. of households)</td>
<td>859 (25)</td>
<td>223 (19)</td>
<td>1,082</td>
</tr>
<tr>
<td>No. of trees lost, 1997–2000</td>
<td>786</td>
<td>297</td>
<td>1,083</td>
</tr>
<tr>
<td>Percentage lost to flood/windthrow</td>
<td>80</td>
<td>63</td>
<td></td>
</tr>
<tr>
<td>Percentage lost to tree borers</td>
<td>20</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>No. of trees coming into production, 2000–2003</td>
<td>737</td>
<td>475</td>
<td>1,212</td>
</tr>
</tbody>
</table>
As such, and interestingly, the vertical stratification of land use on the yarinales – into distinct swidden-fallow cycles by elevation – corresponds directly with socio-economic stratification among households in Esperanza. The founding families held more land in the yarinales, higher land, and larger orchards; later arrivals held less land (or none in the yarinales), at lower elevations, and smaller (or no) orchards. Over time, the founding families consolidated their early claims, persisting with profitable avocado (which financed deeper investment in orchards as well as in higher education), whereas later arrivals (with lower yarinales lands) were more vulnerable to periodic high floods – ultimately the latter relinquished their land or shifted to the less profitable swidden-fallow cycles around maize/manioc and banana. In this manner, the lands of the paleomeander island have been instrumental in the evolution of wealth differentiation among peasant households in Esperanza since the yarinales were first claimed and worked in the late nineteenth century.

5.5 Non-Agricultural Resource Use

Though of lesser importance than to swidden-fallow agriculture, the yarinales are a significant source of non-timber forest products, game, and medicinals. Building materials, especially fronds of the yarina palm for thatching and roofing, are drawn from the area, especially the yarina reserve which is protected by households from Esperanza though only lightly managed (i.e., clearing around base when cutting fronds). Game including deer, paca, agouti, peccary, monkeys, and a variety of bird species are hunted on the yarinales, some drawn by the food available in the fields and orchards. During high floods, game tends to concentrate on the high ground and is particularly vulnerable to hunting. Medicinals collected from the forests of the yarinales include lan-cetilla (shrub), ishanga (tree), cusuilla (cane), cituje (tree), shuchahuaito (tree), and requia (tree).

5.6 The Challenges of Future Use

Four challenges beset farmers who work the lands of this paleo-landform. First, the avocado orchards need to be continually renewed. In 2000, producers in Esperanza reported 1,082 avocado trees in production in the yarinales, and during the previous 3 years they had lost an equivalent number to flooding/windthrow (75%) and pest damage (25%) (Table 5.2). Producers projected that 1,212 trees would come into production between 2000 and 2003, or about 12% more than lost. Planting tends to occur in sprouts, typically after 2–3 years of low annual floods, and ceases after a particularly high flood when losses are greatest. Clearly, orchards on somewhat lower land are being renewed, by force of tree mortality, but orchards on the highest grounds –
where many trees are of similar age, often 20–30 years or more old – are not. Standing orchards are renewed with difficulty because young avocado trees require abundant light and seedling mortality due to agouti is high. Typically, residents must wait until an old, poor-producing tree falls and opens a gap before replanting occurs.

Second, farmers are facing increased competition in Iquitos markets from producers elsewhere. Prior to the early 1980s, avocado produced in the Manitu River Basin (down-river from Iquitos) competed with those from Esperanza and Lake Charo, but a large flood in 1982 appears to have significantly reduced orchard production in the region. Today, competition comes from two sources – communities such as Iteben and Perilta, along the Ucayali River, where high levees and *yarin tales* are found close to the channel, and from upland communities along the Iquitos-Nauta road and Iras River. Avocados from these sources are reputed to be smaller and less refined, selling for 50% of the price of Tahuayo avocado. In general, avocado production on the *terra firme* is short lived (1–3 years of fruit production) and requires significant inputs to offset soil poverty, moisture deficits, and the ravages of leaf cutter ants.

A third set of challenges arises in conflicts over land on the yarinales, particularly between the communities of Charo and Esperanza. Charo was established in the late 1920s by people displaced by a high flood along the Amazon River, as a base for extraction of monkeys from the yarinales, fish from Lake Charo, and moriche palm fruit from the swamp forests to the south. Although Charo is much nearer to the *yarinales* than Esperanza, claims over the lands on the paleo-island have been held by families of Esperanza for generations. With little agricultural land available around the village site and having depleted the local stock of monkeys and moriche palm fruit, residents of Charo sought land in the *yarinales*, with only limited success. In December 1991, however, (ex) President Fujimori accompanied by five members of Congress paid an unexpected visit to the lake (a popular sports fishing destination) by float plane. Much impressed by Charo residents’ self-representation as ‘conservatignonist’s of the nearby *yarinales*, the ex-president unswittingly decreed that the community should be granted title over the yarinales. This decree triggered an intense land struggle, but was ultimately disallowed by the regional government, though conflicts persist. In the late 1990s, residents of the community of San Carlos (well inland from the Tahuayo River) sold their orchards to residents of Charo, reportedly because they could no longer afford the effort to prevent theft.

Finally – and perhaps most seriously – the flood regime in the region appears to be changing as the Amazon River began to migrate laterally (eastward) in the 1980s and threatens to re-take the low terrace (see Kalliola et al. 1992; Tsukiki et al. 1996). Residents of Esperanza reported in 1982 that the high levee that separated the Amazon and Tahuayo River systems near Yaca-pana was breached by the Amazon River, and flood waters from the Amazon flowed through Lake Charo and into the Tahuayo River. In 1989, downstream on the Tahuayo River at Huaisi, the Amazon River broke through another
levee and captured the lower Tahuayo along a reach of 13 km. Floodwaters from the Amazon River now cut across Lake Charo for up to 3 months of the year and year-round below Huaiisí. High floods in 1993 and 1994 took a heavy toll on the avocado orchards, with production falling from 157,000 in 1988-1989 to only 75,500 in 1993-1994; by 1999-2000, however, avocado output had recovered to production levels of the late 1980s. In time, residents are concerned that the changing course of the Amazon River may not only bring a new dominant flood regime (i.e., that of the Amazon rather than the Tahuayo River), but also possibly destroy the yarimales and their profitable agroforestry system.

5.7 Conclusions

In this chapter I have described a paleoriverine feature in the Amazon River lowland (várzea) of northeastern Peru where farmers practice a highly productive, sustained, and profitable form of lowland swidden-fallow agroforestry. The site — a paleomeander island covering an area of some 635 ha on a low terrace above the meander bend floodplain of the Amazon, with its 'arena negra' soils — constitutes an ideal site for agricultural production, combining the high fertility of lowland environments with security from decadal flooding. Avocado — a nutrient-demanding and highly water-sensitive crop species — has thrived on the paleo-island as the terminal tree crop for almost a century and provided significant income for peasant farmers for several generations. Elevated phosphorus concentrations in the soil and the presence of poteheeds and stone implements suggest prehistoric use and occupation of the site. Are these 'arena negra' soils though terra pretas? Perhaps not; the paleo-island is clearly a depositional feature and the brown, sandy loams are the likely product of long-term additions of organic matter from the ivory nut palm and phosphorus-rich human detritus to the young Andean alluvium that forms the core of the island. Nevertheless, the high fertility of the soils and the promise for sustainable agricultural development beg further study. The common occurrence of paleoriverine features in the heterogeneous lowlands of the Peruvian Amazon — including paleomeander islands, terraces, high levee fragments, and perched scab small bars — and reports of avocado production elsewhere in the lowlands suggest that similar sites of high agricultural potential and past human use are to be found in the Upper Amazon.

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