

**The Use of Satellite Images in Amazonian Archaeology:
A Case Study in the Upper Rio Negro Basin.**

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Abstract. This work presents the preliminary results of an archaeological survey of the Middle Uaupés river, in the Upper Rio Negro basin. The survey strategy is based on remote sensing, ethnographic and geomorphological data.

Introduction.

Although there is a growing awareness among archaeologists that Amazonia was an important area of cultural innovation [Lathrap (1977)], [Roosevelt et al (1991)], [Rouse (1992)] in the prehistory of the Americas, current knowledge about the past societies of the area is still scanty. The reasons for this picture are several, but two of them are relevant to this presentation. The first refers to the almost complete lack of scale maps (1:25,000 or 1:50,000) for the planning of regional research projects and the plotting of archaeological sites. The second reason is linked to the constitution of the tropical forest itself, where the thick vegetation reduce the number of areas with good archaeological visibility.

As a consequence, current knowledge on Amazonian prehistory is limited on data gathered from archeological sites located mostly along the Amazon's floodplain and the lower courses of its main tributaries [Meggers (1991)], [Roosevelt (1992)]. In many situations, these sites have only been identified because of their monumental size, as it is the case of the hydraulic complexes of Mojos in Bolivia [Denevan (1966)] and of Marajo Island in Brasil [(Meggers & Evans (1957)], [Roosevelt (1992)].

It is thence important that different approaches that focus on the peripheric areas of Amazonia and are appropriate to the scale and ecological conditions of the region be applied to archaeological research projects performed there. The use of re-

mote sensing techniques can be a productive alternative to achieve these goals. In other tropical areas with a similar lack of support documentation or with extensive vegetation cover, remote sensing techniques have been successfully used on different tasks, such as: surveying of ancient networks of irrigation channels in Belize and Yucatan [Adams et al. (1981)], [Pope & Dahlin (1989)]; identification of ancient paths created more than 1,000 years ago in Costa Rica; surveying of hominid fossil in Ethiopia [Asfaw et al. (1990)]. More important, remote sensing also allows for the incorporation of data from different disciplines, such as ecology, geology, geography, and ethnology, in the planning and execution of archaeological research projects [Miller et al. (1991)].

Based on these questions, we used remote sensing data in the planning of an archaeological survey strategy for a marginal area of Amazonia: the Middle Uaupés basin. This region was selected for two reasons. First, it belongs to the Upper Rio Negro basin, an area considered to be an ancient migratory corridor between Central Amazonia and Northern South America [Lathrap (1970)], [Oliver (1989)], [Zucchi (nd)], although no systematic research have yet been performed in this part of Brazil. Second, there is a wealth of ethnographic and ethnohistorical data about Middle Uaupés' populations that can be used to elaborate hypotheses to orient the archaeological research. With the further development of the project, other areas of the Upper Rio Negro basin are planned to be surveyed as well.

Landsat 5 TM digital data was analyzed to identify areas of potential presence of archaeological sites to be checked in the ground. Four of these areas were selected according to a predictive model of settlement location, based on ethnographic and geomorphological data. The results of the first field season of the project, performed in one of these areas in February-March of 1993 are present here.

The Predictive Model

The Uaupés is a blackwater river. Blackwater river ecosystems are considered oligotrophic because of their low nutrient levels, being different from whitewater rivers that support a rich aquatic fauna and periodically fertilize their floodplains [Junk & Furch (1985)], [Golding et al. (1988)], [Moran (1991)].

The Uaupés is a meandering river that has formed several oxbow lakes some of them already filled by sediments along its floodplain [Projeto RadamBrasil (1976)]. In other areas of Amazonia, such as Marajó Island and the Central Ucayali, there is a correlation between these landscape features and archaeological sites [Lathrap (1968a)], [Lathrap et al (1985)], [Roosevelt (1991)] and this could be also the case in the Uaupés. The work with the images showed that old meanders and oxbow lakes present distinctive signature patterns and it was decided to select some of these loci to be checked in the field.

The middle Uaupés basin is characterized by large extensions of white sandy soils spodosols and areas of flooded for-

ests (igapós, that limit the potential areas of cultivation [Ribeiro (1988)]. As a consequence, there is a strong reliance on manioc, since this is a resistant plant that is easy to cultivate and of high caloric yields [Moran (1974)], [Dufour (1983)].

The region is the homeland of Indian groups speaking languages belonging to three linguistic stocks: Arawak, Tukano and Maku [Bruzzi (1962)], [Chernela (1983)], [Goldman (1963)], [C. HughJones (1979)], [Jackson (1983)], [Milton (1984)], [Ramos, Silverwood-Cope & Oliveira (1980)], [Ribeiro (1980)]. The distribution of these groups in the area follows roughly a pattern of ecological specialization: the Maku are hinterland hunter gatherers, while the Arawak and Tucanoan are agriculturalists and fishermen settled along the major streams.

Fishing is the main protein source to the riverine populations in the Upper Rio Negro basin and this is also the case in the Uaupés [Clark & Uhl (1987)]. However, there are spatial and temporal oscillations in the availability of fish along the Uaupés. The implication of this for human occupation in the area is that the main sources of animal protein are spatially and temporally predictable and the local populations are aware of this. Local populations optimize fish catches by including a number of productive fishing spots within their territory, if there are no main ideological or political constraints. Given the distribution of fish species in the Uaupés, an optimally located settlement would have access to

igapós, rapids and confluences of streams [Chernela (1983)].

The ethnohistorical record indicates that settlements located near optimal fishing spots are occupied for long periods of time: some communities adjacent to the major cataracts of the Uaupés have been continuously occupied since the mid-eighteenth century [Bruzzi (1962)], [Coudreau (1886)], [Lopes de Sousa (1956) (c. 1928)], [Nabuco 1903)], [Rodrigues Ferreira (1983 c. 1781)], [Wallace (1905 c. 1850)], [Wright (1981)]. Thence, some of these areas were also selected to be checked in the field.

Based on the model outlined above - and explained in detail in [Neves (1992)], the satellite data was analyzed with the goal to identify the landscape features igapós, rapids, confluence of streams and old meanders potentially associated with past and present human occupation in the area

The Image Analysis

The analysis was done on Landsat V TM digital data of the middle Uaupés (path 004/60, May 1985). It included pre-processing, registration, geo-referencing and clustering and it was done with ERDAS 7.5 at the ACT (Center for Anthropological Training in Remote Sensing), Department of Anthropology, Indiana University and at the remote sensing lab, Department of Geography, Indiana State University.

Unsupervised classifications of the landcover patterns was performed as a preliminary approach because of the lack of support data. A cluster of the

reflectance values of channels 2,3,4,5 in two subareas was performed with the goal of identifying the landscape features included in the predictive model. In both areas 13 different classes were obtained from the original 50 classes generated by the cluster analysis. The merging of the classes was based on the mean values of channels 3 and 5 - visible red and mid-infrared - because they are indicative of biomass and moisture contents. In one of the subareas we were able to identify rapids because they presented a mean reflectance value of 40.29 on channel 3 compared to a mean value of 22.29 on the same channel for the other parts of the river. Two classes of flooded forests were also differentiated because of the low values on channels 3 - 22.87, 22.74 - and 5 - 31.45, 28.86 [Neves (1992)].

The image analysis allowed for the selection of four units to be checked in the field, all of them presenting one or more of the landscape features contemplated by the model. The first field season was performed in February and March of 1993 and the preliminary results are presented here.

Fieldwork: Preliminary Results

The first field season was done around the communities of Iauaretê and Santa Maria, located at the confluence of the Paupuri and Uaupés rivers, at the border of Brasil and Colombia (Coordinates of Santa Maria: 0° 36' 24" N, 69° 12' 14" W, obtained with a GPS receiver).

We were able to identify four archaeological sites, three of them ancient longhouses and

the other one an old fenced village. We believe that all of these places are of recent occupation, the oldest one most likely being the fenced village that was probably occupied in the eighteenth century.

A 2x4 m. trench was opened in one of the ancient longhouses to obtain a sample of the ceramic material and also evaluate the pattern of deposition of the archaeological deposits. The collected samples are now being analyzed in the MAE - USP.

The three ancient longhouses are currently under a pasture area and the sites were identified because part of the remains could be seen on the ground. The old fenced village is now covered by high secondary forest and its archaeological visibility is very low. If it wasn't for oral information, it is likely that this site would not have been found.

Conclusions

The amount of information amassed so far in the project is small, but some preliminary observations regarding the use of the Landsat data can be made:

1. Landsat V TM was instrumental in selecting the areas to be surveyed in the field but, the analysis we performed could not pinpoint the actual location of the sites on the ground;

2. The pixel size of the TM data (30x30 m.) is too big to record the archaeological features so far identified in the Middle Uaupés;

3) The analysis we performed in the TM data could not identify

the area of secondary growth were one of the sites - the old fenced village - is located.

The above observations are still provisional but they indicate the limitations and potential of the TM data for the proposed research. Further work in the area will bring new information to improve the conclusions now presented.

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