HISTORICAL LOGGING IN EASTERN PANAMA

GENESIS OF A SOCIAL-ECOLOGICAL LANDSCAPE

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Field days: 18

8 in Piriatí

2 in Ipetí

2 in Chepo

7 in Panama City

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EXECUTIVE SUMMARY

The Upper Bayano watershed in eastern Panama has undergone dramatic land-use and land-cover change (LUCC) in the past 40 years, including extensive deforestation in a highly biodiverse ecoregion. Much of the literature on the Bayano has focused on the impacts of a large hydroelectric dam and the subsequent expansion of the Pan-American Highway in the 1970s. The dam created a 35,000 Ha' (350 km^2) reservoir and displaced 4,000 people, including indigenous Kuna and Emberá peoples, as well as non-indigenous migrants to the agricultural frontier known as *colonos*. It is generally argued that the infrastructure projects disrupted traditional indigenous land-use practices, and facilitated an influx of *colonos* who destroyed the virgin forest to create cattle pasture. One potential challenge to this narrative is the fact that during the 1970s, the government-owned regional development agency known as the Bayano Corporation was participating in large-scale logging activities in the Bayano region.

Little is known about the extent of the Bayano Corporation's logging activities at the time, and what were the impacts on subsequent LUCC patterns in the region. The first objective of this research is therefore to historically, geographically, and quantitatively document timber extraction in the Upper Bayano region during the 1970s. The goal is the recreate a historical narrative, including where the logging took place and how much timber was cut. The second objective is to work with members and leaders of the community of Piriatí-Emberá, a village that was formed in 1977 to accommodate Emberá people who were displaced by the dam, and contribute to their goal of better understanding their environmental history.

There were four primary research activities. The first activity was a search for historical documents in libraries and government agencies, which were added to a collaborative archive of documents related to the Bayano. The second activity was interviews with experts and key informants in Panama City and Chepo, including former employees of the Bayano Corporation. The third activity was interviews with elders in Piriatí who were among the first settlers of the village, as well as elders in the neighboring village of Ipetí who were also forced to relocate when the dam was constructed. All 19 interviews were unstructured, and lasted between 30 minutes and four hours. The fourth activity was to collect and curate a database of geospatial data, and digitize any geographic information that resulted from the other research activities. For all the research activities, the sampling method was based on an open-ended "snowball" approach; I looked for and investigated any potential source of information.

The government has been involved in logging activities in the Bayano since at least 1967, but only began large-scale logging in 1974 in response to a World Bank environmental study that recommended that the flooded area should be cleared of vegetation. The government created the Project for the Integrated Development of the Bayano (PDIB) to oversee the deforestation and the relocation process for the people who would be affected by the dam. PDIB clear-cut roughly 8,000 hectares, but as costs began to rise for the resettlement program, they also began selectively logging to generate income. In 1976 PDIB was converted into the Bayano Corporation, and given financial autonomy. Taking advantage of the newly-constructed Bayano Bridge, the Bayano Corporation expanded its selective logging activities

and penetrated eastward well beyond the limits of the reservoir. For the rest of the 1970s, the Bayano Corporation continued to selectively log the entire flat area of the Upper Bayano.

I estimate that the total timber extraction during the 1970s was roughly 45 million board ft., corresponding to 22,500 trees. Of that total, 37 million board ft. was from selective logging, corresponding to 18,500 trees. The total volume extracted is quite low with respect to the entire forest. According to the estimate of total timber extraction, only 0.6% of the total timber volume in the Bayano region's commercially harvestable forest was extracted by logging in the 1970s. Therefore timber extraction was likely not the proximate cause of the dramatic LUCC that has occurred since then. Instead, it was an indirect driver of LUCC because it fragmented the forest, affecting the local ecology as well as local land-management decisions. Most importantly, it opened up logging roads that penetrated deep into the primary forest, allowing migrant farmers to convert the impacted forest into agricultural fields and cattle pastures.

To my knowledge, this is the first attempt to document timber extraction in the Bayano during the 1970s, and link it to subsequent land change patterns until the present. At the local level in Piriatí, it dramatically challenges the widely-held understanding within the community that they are responsible for destroying the primary forest. At the regional level, it broadens the narrative about how the region came to lose so much of its forest. At the global level, it serves as a warning to all selective logging projects to be conscious of the indirect impacts of their activities on subsequent land-use decisions.

RESUMEN EJECUTIVO

La cuenca del Alto Bayano en el este de Panamá ha experimentado un cambio dramático en el uso del suelo y de la cobertura vegetal (LUCC, por su nombre en inglés) en los últimos 40 años, incluyendo la deforestación extensiva en una eco-región con un alto nivel de biodiversidad. Gran parte de la literatura sobre el Bayano se ha centrado en el impacto de una gran represa hidroeléctrica y la posterior ampliación de la Carretera Panamericana en la década de 1970. La presa creó un embalse de 35,000 Ha ' (350 km2) y desplazó a 4.000 personas, incluyendo indígenas de etnia Kuna y Emberá, así como migrantes campesinos hacia la frontera agrícola conocidos como "colonos". Por lo general, se sostiene que los proyectos de infraestructura interrumpieron las prácticas tradicionales indígena de uso de tierra, y facilitaron le entrada de colonos que destruyeron el bosque virgen para crear potreros. Un desafío potencial de este relato es el hecho de que durante la década de 1970, la agencia gubernamental de desarrollo regional conocida como la Corporación Bayano estaba participando en explotación forestal a gran escala en la región.

Poco se sabe sobre la explotación forestal de la Corporación Bayano en el momento, y cuáles fueron los impactos en los patrones de LUCC posteriores en la región. El primer objetivo de esta investigación es documentar históricamente, geográficamente y cuantitativamente la extracción de madera en la región del Alto Bayano durante la década de 1970. La meta es

recrear una narración histórica, incluso donde se taló y la cantidad de madera que fue cortada. El segundo objetivo es trabajar con los miembros y líderes de la comunidad de Piriatí - Emberá, un pueblo que se formó en 1977 para acomodar gente Emberá que fueron desplazados por la presa, y contribuir a su objetivo de una mejor comprensión de su historia ambiental.

Había cuatro actividades principales de investigación. La primera actividad fue una búsqueda de documentos históricos en bibliotecas y agencias de gobierno, que se añadieron a un archivo colaborativo de documentos relacionados con el Bayano. La segunda actividad fue de entrevistas con expertos e informantes clave en la Ciudad de Panamá y Chepo, entre ellos ex empleados de la Corporación Bayano. La tercera actividad fue entrevistas con moradores de mayor edad en Piriatí que se encontraban entre los primeros pobladores de la comunidad, así como los ancianos de la comunidad vecina de Ipetí que también se vieron obligados a trasladarse cuando se construyó la represa. Las 19 entrevistas fueron no estructuradas y duraron entre 30 minutos y cuatro horas. La cuarta actividad era recopilar una base de datos de los datos geoespaciales, y digitalizar toda la información geográfica que resultó de las otras actividades de investigación. Para todas las actividades de investigación, el método de muestreo se basó en un enfoque de "bola de nieve"; Busqué e investigué cualquier fuente potencial de información.

El gobierno ha estado involucrado en explotación forestal en el Bayano al menos desde 1967, pero sólo empezó la tala a gran escala en 1974 en respuesta a un estudio de impacto ambiental del Banco Mundial que recomendó que la vegetación en el área inundada deba ser removida. El gobierno creó el Proyecto de Desarrollo Integral del Bayano (PDIB) para supervisar la deforestación y el proceso de reubicación de las personas que se verían afectadas por la represa. PDIB tumbó aproximadamente 8.000 hectáreas de bosque, pero a medida que los costos comenzaron a subir por el programa de reasentamiento, también comenzó la tala selectiva para generar ingresos. En 1976 PDIB se convirtió en una agencia de desarrollo regional semiautónomo (la Corporación Bayano). Aprovechando el Puente Bayano recién construido, la Corporación Bayano amplió sus actividades de tala selectiva y penetró hacia el este más allá de los límites del embalse. Para el resto de la década de 1970, la Corporación Bayano continuó talar selectivamente toda la zona plana del Alto Bayano.

Estimo que la extracción total de madera durante la década de 1970 fue de aproximadamente 45 millones de pies tablar, correspondiendo a 22.500 árboles. De ese total, 37 millones de pies tablar eran de la tala selectiva, correspondiendo a 18.500 árboles. El volumen total extraído es muy bajo con respecto a todo el bosque. Según la estimación de la extracción total de madera, sólo el 0,6 % del volumen total de madera en el bosque comercialmente explotable de la región de Bayano se extrajo por la tala en los años 1970. Por lo tanto, la extracción de madera probablemente no fue la causa inmediata de la dramática LUCC que ha ocurrido desde entonces. En su lugar, se trataba de una causa indirecta del LUCC, ya que fragmenta el bosque afectando la ecología local, así como las decisiones locales de manejo de tierras. Lo más importante, abrió caminos forestales que penetraron profundamente en el bosque primario, lo que permite a los agricultores migrantes para convertir el bosque impactado en los campos agrícolas y pastos para ganado.

A mi entender, este es el primer intento de documentar la extracción de madera en el Bayano durante la década de 1970, y vincularlo a los patrones de cambio de la tierra posteriores y hasta la actualidad. A nivel local en Piriatí, cuestiona radicalmente la comprensión muy extendida dentro de la comunidad que son responsables de la destrucción del bosque primario. A nivel regional, se amplía el relato de cómo la región llegó a perder gran parte de su bosque. A nivel mundial, sirve como una advertencia para todos los proyectos de tala selectiva para ser consciente de los impactos indirectos de sus actividades en las decisiones posteriores de uso del suelo.

INTRODUCTION

TRANSFORMATION OF THE AREA

At the western front of the Choco-Darien ecoregion, one of the world's biodiversity hotspots (Mittermeier et al., 1999), the Upper Bayano watershed in eastern Panama has undergone dramatic land-use and land-cover change (LUCC) in the past 40 years (Potvin et al., 2006). During the 1970s, the construction of a large hydroelectric dam and the subsequent expansion of the Pan-American Highway led to the transformation of the region from a forest frontier into an agricultural area integrated in the national economy (Wali, 1989).

The construction of the hydroelectric dam was carried out in the name of national progress and economic independence. At first the project had broad support within Panama, and was seen as an opportunity to benefit the poor and modernize Panama's infrastructure (Wali, 1989; Wali, 1993). Government planners at the time also saw the project as an opportunity to develop the mostly-empty Bayano region, under the auspice of a semi-autonomous state-run regional development agency called the Bayano Corporation (Wali, 1989). Construction of the dam began in late 1972, and after some delays, the gates closed on March 16, 1976 (Wali, 1989). Financed by loans from the World Bank and private commercial banks, the dam represented one of the first major accomplishments of the military regime of General Omar Torrijos.

The project had many negative and unintended consequences. According to the World Bank's criteria, the Bayano is considered a "particularly 'bad' site" for a hydroelectric dam due to a "large flooded area with high hectares per megawatt ratio, long water retention time, much biomass flooded, long stretch of river impounded, and high fish diversity" (Ledec & Quintero, 2003, p.13). The dam created a 35,000 Ha' (350 km^2) reservoir, and displaced 1,500 indigenous Kuna, 500 indigenous Emberá, and 2,500 *colonos* (non-indigenous migrants to the agricultural frontier) (Wali, 1993). The three ethnic groups continue to have conflict over land rights and legal land title (e.g. IACHR, 2012).

Much of the literature on the Bayano focuses on how the dam and related infrastructure projects disrupted traditional indigenous land-use practices, and facilitated an influx of *colonos* who destroyed the forest to create cattle pasture (Wali, 1989; Wali, 1993; MIDA/RENARE, 1979; Jaén et al., 1986). A number of theories have been proposed to explain LUCC in agricultural frontier zones, but the dynamics are still poorly understood in many tropical contexts (Lambin et al., 2003; Sloan, 2007).

In the neotropics, it is generally understood that the expansion of agriculture and cattle ranching are major drivers of deforestation and land degradation (Heckadon Moreno, 1983; Kaimowitz, 1996; DeWalt, 1983; Mahar & Schneider, 1994). However, LUCC is a result of complex interactions between social, ecological and geophysical processes (Munroe & Müller, 2007). To understand current LUCC dynamics in a given area, it is important to consider the historical context of LUCC on a case-by-case basis (Sloan, 2007).

Sloan (2007) systematically reviews four of the prevailing LUCC theories[1] with respect to the Bayano, and concludes that none of the theories satisfactorily explain current LUCC. Instead he argues that current dynamics are closely related to historical land-cover change, and advocates the concept of LUCC "pathways" or trajectories.

This report is part of a larger research effort led by Dr. Catherine Potvin to understand the environmental history of the Upper Bayano region, in order to better interpret current trends and empower stakeholder groups to resolve their conflicts. One of the ongoing research initiatives is a study led by Divya Sharma on land use change in Piriatí, one of the villages formed to accommodate the displaced Emberá.

According to Wali (1989), after being relocated to Piriatí, farmers were disinclined to use intensive land management techniques because of insecurity over land rights, causing land degradation. In fact, Piriatí is still fighting for legal recognition of its collective lands. In the area surrounding the community, there is very little primary forest remaining, and the land is now mostly under shifting cultivation (Map 1). During the course of Sharma's study, community members have expressed that they feel responsible for the loss of primary forest (Sharma et al., in progress).

However, preliminary evidence from the research, including video footage from a series of documentaries produced in the 1970s, suggests that when the village was settled in 1977, much of the land had already been logged by the state-owned Bayano Corporation (GECU, 1974). This research is partly motivated by interest from within the community, including the

[1] The Household-Life Cycle Thesis, the Boserupian Thesis, the Hollow-Frontier Thesis, and the Forest-Transition Thesis

leadership, to know more about the early environmental history of the community. They want to know why they do not have more primary forest – did they mismanage the land, or did they simply never have primary forest to begin with?

STUDY OBJECTIVES

1. To document historically, geographically, and quantitatively the timber extraction by the state and private firms in the Upper Bayano watershed during the 1970s.
2. To work with members and leaders of the community of Piriatí and contribute to their goal of better understanding their environmental history.

STUDY AREA/BACKGROUND

This study investigates the environmental history of the entire Upper Bayano watershed, with a particular focus on the Emberá village of Piriatí, which is located in the southeastern portion of the watershed.

WATERSHED

The Bayano region is located in the District of Chepo in the southeastern section of the Province of Panamá. It is part of the Chocó-Darién tropical forest eco-region, which comprises the eastern Panamanian provinces of Panamá and Darien and the Department of Chocó in Colombia.

The entire Bayano River watershed is 605,200 Ha', and represents 8% of national land surface (MIDA/RENARE, 1979). This study focuses on the Upper Bayano area, the 365,200-

hectare portion of the watershed above the dam. The region is bounded by the San Blas Mountains to the North, and the Maje Mountains to the South.

The climate of the Bayano region is tropical and humid. Average daily temperature ranges from 24˚C to 26˚C (Louis Berger Group, 1998). There are two seasons based on precipitation: an eight-month rainy season (mid-April to mid-December), and a four-month dry season (mid-December to mid-April) (Figure 1).

According to the Holdridge life zone system, most of the area is a "tropical moist forest", or more specifically seasonal yet evergreen tropical rain forest (Map 2) (Tschakert et al., 2007). The Bayano Corporation measured Forest Cover of the Upper Bayano using the management classifications in Table 1.

The forest can be divided into two broad vegetative groups, with three strata (Jaén et al., 1986). The first group consists of large trees such as *espave* (*Anacardium excelsum*) and *cuipo* (*Cavanillesia platanifolia*), as well as other timber species such as *cedro espino* (*Pachira quinata*) and *cedro macho* (*Guarea grandifolia*) (Jaén et al., 1986; Perez & Condit). Selective loggers look for areas of forest with high densities of such trees. The second vegetative group consists of shrubs and smaller non-timber trees such as *higuerillo* (*Ricinus communis*), *berba* (*Brosimum* sp.), *guabo* (*Inga* sp.), *caucho* (*Hevea brasiliensis*), *sigua* (*Nectandra sp.*), *yaya* (*Unonopsis* sp.), etc. (Jaén et al., 1986; Perez & Condit).

PIRIATÍ

Piriatí is roughly 100 km from Panama City along the Pan-American Highway, and has a population of approximately 700 people. There are roughly 60 landowning households who practice swidden-fallow agriculture and some cattle ranching on individual plots of land. The community is clustered along one road stemming off the Pan-American Highway, and is set on 3754 hectares of communal land (*tierra colectiva*) that is not yet legally recognized by the government. Most people live in the community itself, although some live on their plots of land outside of the community (Sharma et al., article in preparation).

METHODS

In addition to a literature review, the primary research activities were:

1. Searches for historical documents in Panama City and Chepo, and contributions to a collaborative electronic archive of documents related to the Bayano;
2. Interviews with experts and key informants in Panama City and Chepo, including former employees of the Bayano Corporation; and
3. Interviews with elders in Piriatí who were among the first settlers of the village, as well as elders in the neighboring village of Ipetí who were also forced to relocate when the dam was constructed.
4. Curating a database of geospatial data and digitizing geographic information from the interviews.

The nature of the research objectives presented several methodological challenges that are common to historical investigations. The sampling method was based on an open-ended "snowball" approach; I looked for and investigated any potential source of information. Given the impossibility of designing a systematic sampling structure, I borrowed from the historical method known as source criticism to evaluate my sources. More specifically, I used the seven-step procedure for source criticism proposed by Langlois & Seignobos (1900) (Appendix 5).

Other methodological challenges were logistical in nature. For example, many of the people involved in the Bayano logging industry during the 1970s are either no longer living, or no longer live in the area and could not be reached.

DOCUMENT SEARCH AND ARCHIVING

Last year, students from the Panama Field Studies Semester (PFSS) created an EndNote archive of documents and references related to the Bayano. Their project was named "Archiving the History of Land-use Planning and Territorial Conflict in the Upper Bayano Basin of Panama" (Gordillo &Thomas, 2013). The electronic database includes digital versions of many of the documents, and instructions for how to find the hard-copy of documents for which there is no digital version. The archive helped me begin the document search for this project, and gave me a sense of where I might look to find non-digitized documents related to my research topic. Throughout the course of this research project I built upon the archive, adding the documents that I found using the same method Gordillo &Thomas used. I added 41 documents to the archive, bringing the total to 95 documents.

I searched for documents at the following places:

1. Archive (Centro de Documentacion) of the National Environmental Authority (ANAM) in Panama City
2. ANAM office in Chepo
3. Government Accountability Office (Contraloría Nacional) in Panama City
4. Smithsonian Tropical Research Institute (STRI) Library in Panama City
5. University of Panama Library in Panama City

One of the main challenges of the document search was the difficulty in finding original sources. In many cases, key informants told me of original documents that had been misplaced or thrown out due to a lack of archiving procedures in government offices, carelessness, or

perhaps even fraudulence. I was only able to find one document from the Bayano Corporation itself, which was misplaced on a shelf at the ANAM's Centro de Documentación. All of the original documentation from the Bayano Corporation has either been lost, or as several sources allege, it was systematically destroyed in the late 1980s or early 1990s to cover up corruption.

Unstructured interviews

I conducted 19 unstructured interviews with 20 individuals. For a complete list of the interviewees, see Table. There was no set questionnaire for the interviews, but I tried to ask questions about information that I could check, to test the reliability of the answers that I would not be able to validate. The interview approach was generally different for the experts/key informants than it was for the community elders, but the interviews were all somewhat different from each other. For the experts/key informants the goal was primarily to get broad information about regional-level events or processes. For the community elders, the goal was to document their personal experience. The shortest interview lasted 30 minutes (out of consideration for the poor health of one elder), but most lasted between two and three hours. The longest interview, with a Forestry Engineer at ANAM, lasted four hours.

Mapping and Geodatabase curation

I used three techniques to spatially document historical timber extraction in the Bayano. All GIS work was done in ArcMap 10.1 from ESRI.

First, I entered any spatial information I found in my document search or that was given to me by key informants into a geodatabase, and used the GIS for visualizing the data. The

geodatabase includes a number of base layers and general data available from the STRI library (e.g. roads, rivers, topography, Holdridge life-zones), as well as two aerial photos from 1973, one image of a hand-drawn map from 1973, and historical Landsat Imagery (available free online through the USGS archival service).

Second, I used a simplified participatory mapping exercise in nine of the interviews. I carried a large paper map with me, and asked the interviewees to identify where logging camps had been, which areas had been deforested, and any other spatial information they could remember. I digitized the results and included them in the geodatabase.

Third, I used the GIS to draw polygons of where logging might have taken place, for diagrammatic purposes. To determine where selective logging could have happened, the only geographical feature considered was topography. Essentially, I used the Digital Elevation Model topography layer to draw a rough polygon of the flat area surrounding the Bayano River. Given the limited resources available for this study, and the unavailability of reliable historical spatial data, a more rigorous spatial analysis was not attempted.

RESULTS

BACKGROUND HISTORY

Three main groups of people live in the Upper Bayano today: the indigenous Kuna and Emberá peoples, and non-indigenous *campesinos* (small-scale farmers) known as *colonos.*

The Kuna were indigenous to the area when the Spanish arrived (de Arauz, 1975; Howe, 1977), and a small group of runaway slaves and their descendants had settled as early as the 16th century (Fortune, 1970). In the mid-1800s, most of the Kuna migrated to the San Blas archipelago, but they remained in contact with the Bayano Kuna through kin and trade. In 1925, after a bloody revolution, the Panamanian government acceded the San Blas region as a semi-autonomous indigenous Comarca. Meanwhile, near the Bayano region, people had begun to settle east of Chepo. Following the example of their kinspeople in San Blas, the Bayano Kuna negotiated for the establishment of a reserve along the Bayano River and its tributaries as a preventative measure to avoid encroachment on their lands (Wali, 1989).

In the 1950s, the gradual extension of the Pan-American Highway facilitated migration into the region. A small group of Emberá, who are not originally indigenous to the Bayano, migrated from the Darien to take advantage of easier access to urban markets, and practiced slash-and-burn agriculture (Wali, 1993).

Colonists also began to migrate to the region from western Panama, with the intent of clearing land for pasture. Most colonists came from the Provinces of Los Santos, Veraguas, and Coclé, where cattle ranching had been extensively practiced since the 18th century, and where

small-scale pastoralists were losing their land to soil degradation and an inequitable land tenure system (Heckadon Moreno, 1983; Wali, 1993).

1967 to mid-1973: Early Government Activity in the Region

Early Timber Extraction

The government had been involved in timber extraction in the Bayano since 1967 or earlier. Between 1967 and 1972, the government operated two or three bulldozers during the dry season, cutting logging trails along the Bayano River (former Forestry Camp Director for the Bayano Coporation). There was no bridge yet; heavy machinery could forge the river when the water was low (Photo 1), but it was not practical for logging trucks to cross the river to carry out timber. Instead, the loggers floated logs downstream and picked them up at a collection point where trucks could enter, which caused a major bottleneck and restricted productivity (Photos 2 and 3) (former Forestry Camp Director for the Bayano Coporation).

During this period the government loggers cut *cativo* (*Prioira copaifera*) and *espave* (*Anacardium excelsum*), which were mostly sent to the Chagres and MADECA sawmills in Panama City, as well as to several plywood processing companies (Universal Plywood, Panama Plywood, Madera Laminada Las Cumbres) (Elio Diaz). In February 1973, Webb (2008) reported seeing logging trucks between Cañita and the Bayano River, “each carrying three huge logs”.

First studies of affected populations

The original plans for the hydroelectric complex did not include any provisions for the social impacts on the directly affected population (Herrera, unpublished). In 1971, a small group of

anthropologists from the government's Department of National Heritage (*Patrimonio Histórico*) led by Dr. Reina Torres de Araúz carried out a study of the indigenous population that would be affected (Photo 4). At the time, the authorities were not aware of the considerable *colono* population from Los Santos and Herrera (Herrera, unpublished).

The Department of National Heritage study produced two detailed reports – one for the Kuna, and one for the Emberá community of Majecito – and made 22 recommendations for how to handle the relocation of each population (Torres de Arauz *et al*., 1971). By late 1972, the government formed a small interagency group to handle the relocation. The five-person team had one anthropologist, two social workers, and one administrator, and was led by a civil engineer named Ascanio Villalaz (Wali, 1989; Herrera, unpublished). The group identified itself as the Proyecto de Emergencia para el Bayano (Emergency Project for the Bayano), and operated with funds from the Ministry of Planning and IRHE (Wali, 1989, p. 56). It began to establish contact with the local population, but lacked resources and authority to take any concrete measures (Wali, 1989; Herrera, unpublished), let alone to implement the comprehensive recommendations outlined in the Department of National Heritage reports.

1973 – MID-1974: INITIAL CLEAR-CUT, PROJECT FOR THE INTEGRATED DEVELOPMENT OF THE BAYANO EXPANDS LOGGING TO FUND RESETTLEMENT

PROJECT FOR THE INTEGRATED DEVELOPMENT OF THE BAYANO

In 1973, the World Bank funded the first environmental impact assessment of the dam, authored by Felix McBryde and known as the McBryde Report (Wali, 1989, p. 51). One of the

main recommendations of the assessment was that the trees in the reservoir basin should be cleared to avoid sedimentation and other problems, such as the proliferation of aquatic weeds and damage to boats (McBryde, 1973).

When the McBryde Report came out in 1973, the dam was expected to be finished by mid-1975. The Ministry of Planning made the decision to coordinate the resettlement and deforestation efforts, under the leadership of Ascanio Villalaz. In November, by legal decree (Decreto 117 del 15 de noviembre de 1973), the Emergency Project for the Bayano team was expanded into a more official entity, and its name was changed to the Project for the Integrated Development of the Bayano (known as PDIB for its Spanish title). Under PDIB, the government's role in the Bayano expanded rapidly. The project was given 18 months to:

1. Determine the number of people who would be affected and estimate the value of their goods and property, so as to plan and execute a relocation and compensation process.
2. Clear the vegetation from the area to be flooded, and recover the timber resources.
3. Conduct ecological inventories of the flora and fauna, including the aquatic ecosystem (to assist in managing possible eutrophication of the reservoir)
4. Take preventative measures to avoid bio-medical problems that are common to dam projects.

Source: Herrera, unpublished.

At the same time, the Pan-American Highway was being paved from Cañitas and the Bayano Bridge was under construction. Both projects were completed in 1975 (Photos 5) (Webb, 2008; Wali, 1989).

12,000 Ha' DEFORESTATION EFFORT

Until 1973, the government's logging activities had been relatively modest, and based on selective-logging (former Forestry Camp Director for the Bayano Corporation). In January 1974, based on the recommendation of the McBryde Report, the government launched a major clear-cutting effort to completely deforest 12,000 Ha' of the principal reservoir, in the area where the Bayano and Majé Rivers met (Wali, 1989, p. 52). The clear-cutting was carried out over two years, from 1974 to 1975. According to Berbey (1975), 12,600 hectares were deforested producing 8 million board ft. of wood (Photo 6). However, according to one interviewed forestry supervisor, only 60-70% of that total was actually completed (roughly 8000 Ha'). Wali (1989) estimates that less than 50% of the planned amount was actually cleared (p.53).

Originally, the PDIB thought that it could recover its costs for the project by selling the valuable hardwoods in the cleared area. To oversee the lumbering activities, 26 independent small loggers were brought in from the Darien (Conte, 1981; Elio Diaz, personal communication). Of the 26, seven stayed and were given areas to work on (Elio Diaz). PDIB also hired roughly 1000 workers to carry out the deforestation. They moved in crews of roughly 250 workers on each side of the river: 100 men with machetes clearing brush, 75 with axes cutting small trees, and 75 with saws cutting large trees. Chainsaws were used to cut the timber after it was felled (GECU, 1974) (see Table for list of tools bought by PDIB to carry out 1974

deforestation). Fire was also used to clear the remaining vegetation on 2,300 hectares, the largest controlled fire in Panamanian history at the time (Photo 7) (GECU, 1974).

A 1974 documentary commissioned by PDIB, and produced by the University of Panama's Experimental Cinema Group (GECU), shows the living and working conditions. Workers lived in large camps made of wood and thatch with no walls, exposed to the elements and insects (GECU, 1974). After long days of taxing physical labor, sometimes food rations did not arrive because the supply trucks would get stuck on the difficult roads; one interviewee mentions that three trucks broke down in a single week trying to bring in food (GECU, 1974).

At first, workers were brought in from western Panama, but they did not have the necessary skills and were not accustomed to the harsh environment (Wali, 1989, p. 52). They were quickly replaced by workers brought in from Colombia because they had more experience as lumberjacks and could handle the jungle conditions. The logging operation was stretched thin – due to labor shortages, and to save money, they used two infantry divisions of the National Guard (*Guardia Nacional*) as lumberjacks because they were already drawing government salaries (Wali, 1989, p. 52). As a result many of the workers were inexperienced and inefficient. According to one man who worked as a chainsaw operator's assistant, there were many avoidable injuries due to a lack of familiarity with the equipment.

FIRST RESETTLEMENT PLAN

One of the first activities of the PDIB was to conduct a census of the affected population and their lands (Herrera, unpublished). They found that in 1973 there were 4,123 people living in the area, of which 53% were *colonos*, 33% were Kuna, and 14% were Emberá (PDIB, 1974).

The study revealed that there were far more colonos living in the area than was previously thought, and PBID would need to plan the compensation and relocation program accordingly (Herrera, unpublished).

The first plan that PDIB developed prioritized the protection of the forest within the watershed. Members of the resettlement team saw the relocation process as an opportunity to help the indigenous groups and the colonos to modernize their production systems. However, in giving territorial concessions within the watershed, they favored the indigenous groups over the colonos because of their ecologically friendly subsistence agriculture and agroforestry systems (Wali, 1993). The first resettlement plan was as follows:

1. The area directly surrounding the reservoir would be left as uninhabited forest.
2. The Kuna would be clustered around the headwaters of the Bayano, in an area of equal size to their 1935 reserve.
3. The Emberá would be resettled into villages in the Darien province, and given technical assistance.
4. The colonos would be settled in communal farms on lands appropriated from wealthy ranchers between Pacora and Chepo

Source: (Wali, 1993)

RISING COSTS

Before the 1973 regional census, IRHE had internally estimated that a relocation program in the Bayano would cost B/ 300,000 (Herrera, unpublished). However, the cost

estimate for the resettlement process ballooned as a result of the new census and PDIB's ambitious agricultural plans.

According to the 1973 census, PDIB had to compensate the roughly 500 *colono* families for 7,000 hectares of pasture, as well as 30,000 hectares that they declared as "extension" lands that were planned for pasture (Herrera, unpublished). PBID also bought 8,000 head of cattle from the *colonos* (Wali, 1989). By this point, PBID had already begun to buy land in the area between Pacora and Chepo. The idea was to break up the large estates in the area and use them to resettle *colonos* and establish large state-run farms practicing mechanized agriculture (Wali, 1989). As a result, the compensation costs for the resettlement program were now estimated to be B/ 3,000,000, a ten-fold increase (Herrera, unpublished).

RESISTACE TO THE PLAN

Not only was the plan expensive, but all three stakeholder groups resisted it (Wali, 1989). The Kuna did not want to move to new lands, but sought to protect the lands they already had (Herrera, unpublished). Many were convinced that the dam would not affect them; in early 1974, a *nelegua* (a female Kuna psychic who can predict the future), predicted that a flood would wipe out the dam, and that the waters would not actually rise (Herrera, unpublished). To the Bayano Project, the Kuna argued that due to their low-impact lifestyle and production system, they should be left in the area to continue protecting the forest (Herrera, unpublished).

In March 1974, a group of Emberá men began to move to the Membrillo River, a tributary of the Chucunaque River in the Province of Darien (Pastor, 1985). This effort failed due to an

infestation of black flies known to the Emberá as "*morrongoy*", a potential vector onchocerciasis, or river blindness. The group returned after three months (Pastor, 1985; Wali, 1989).

The *colonos* were not interested in communal farming, and only 30 families accepted the offer (Wali, 1993). Most demanded compensation and negotiated the terms independently, agreeing to find lands elsewhere (Herrera, unpublished).

LOGGING INCOME

While PDIB was working on deforesting the area in the primary reservoir, they also began selective logging farther east. From a logging perspective clear-cutting a dense tropical forest is not efficient since most trees have no commercial value. In fact, large areas may have no commercial timber at all (Elio Diaz, Federico Camargo). Instead, it is much more profitable to log selectively, finding areas with high concentrations of commercial timber and focusing on harvesting the most valuable species. As PBID's relocation and agricultural expenses grew, selective logging came to be the financial "backbone of the Corporation" (Bayano Corporation, 1982).

In February 1974, there were bulldozers opening up logging roads through the forest west of Torti (Webb, 2008). According to Elio Diaz, in the first season they harvested from roughly where Quebrada Cali, Parti, and Huacuco are now located. There were at least one and possibly two logging camps in Catrigandi, just east of where Piriati is today.

MID-1974 - 1975

LOGGING

Once the Bayano Bridge opened in late-1974/early-1975, logging activity accelerated dramatically. According to the director of one of the logging camps at the time, it was far more efficient to transport logs by truck than by river.

Writing in his journal on March 22, 1975, Webb commented “at the Bayano River Bridge there were so many trucks racing by I felt like we were in New York City”. Bulldozers had opened up new trails and expanded old ones, making it possible for vehicles to advance in one day what it had taken six days just one year before (Webb, 2008). Arriving two days later in Tortí, Webb wrote “the fallen trees covered such a wide area it seemed impossible to find a way around them”. According to a former Logging Camp Director for the Bayano Corporation, the loggers harvested as far east as Cañazas that year.

CEAMM SAWMILL

By the end of the 1974 dry season, PDIB had produced more timber than it could sell to the sawmill companies in Panama City (Conte, 1981). To process some of the timber from the Bayano region, PDIB built the CEAMM sawmill (Centro de Acabado y Mercadeo de Madera). The sawmill employed roughly 50 people, and had roughly one hectare of roofed workshop area and five hectares of patio for storing logs (former CEAMM Director). Nevertheless, they were only able to process 15-20% of the timber harvested by PDIB – most was still sold as logs to other processors.

According to the former Director of CEAMM, the operation eventually grew to become the most sophisticated sawmill in all of Central America. However, it only produced boards, and never made any added-value products such as doors or furniture (former CEAMM Director). For the first four years, the eight-inch saw averaged 3,000-4,000 board ft. per day, and the patio usually had one to two million board ft. of lumber waiting to be processed at any given time (former CEAMM Director).

MOVE TO PARTI

After the failed attempt to resettle the Emberá on the Membrillo River in Darien Province, PDIB decided to look for alternative sites for them to live within the Bayano Region. They identified the Partí River as a potential site for the residents of Majecito (Photo 8)(Wali, 1989). The site would be roughly one kilometer from the lake and five kilometers from the Pan-American Highway. The people of Majecito relocated gradually to Partí between December 1974 and June 1975 (Pastor, 1985).

At the same time, the program to expropriate *colono* lands was failing; 85% of the *colonos* living in the area were compensated for their lands, but many stayed within the watershed or moved further east into the Darien (Yanguez, 2004; Herrera, unpublished). Dispersed farmers remained along several of the rivers, and *colonos* living in the settlements of Torti, Tres Quebradas, and Aibir-Partí also avoided expropriation (Herrera, unpublished). Some *colonos* even received land in the Province of Colon, and then quickly returned to the Bayano (Yanguez, 2004). Others did leave, but many more arrived from other areas, taking advantage of the new bridge. In 1975, the regional population grew 75-100% due to *colono* migration,

creating the new settlements of Nicora, El Puente, Higueronal, Playa Chuzo and Cañazas along the proposed route of the Pan-American Highway (MIDA/RENARE, 1979).

The main priority of the displaced Emberá was to find land without *colonos*. To their dismay, when they arrived in Partí, they found two established *colono* families already living there, and another *colono* farmer who had recently arrived. They had already cleared over 100 Ha' for pasture, mostly upriver from where the Emberá settled (Piriatí elders). Further, the *colono* families claimed to have title to their land. In fact, they had applied for title but had not yet received it; nevertheless the government was unable to force them away (Francisco Herrera, unpublished).

PDIB set up a logging camp in Partí shortly before the Emberá arrived from Majecito. The camp was directly across the Partí River from the houses; estimates of the number of workers range from 20 to 100. During the two years that the Emberá lived in Partí, the loggers worked eastward from the Partí River, going upriver (south) until the steep hills began. Downriver (north), they worked all the way to the Bayano River, where two PDIB logging groups were clear-cutting and burning the vegetation in the area (Piriati elders).

Due to the presence of *colonos* and the logging camp, the Emberá did not plan on staying long in Partí. For the two planting seasons that they lived there, they did not farm near the community since it was too much effort to clear the forest, but instead took advantage of the cleared land along the Bayano River. Each April, at the end of the dry season and after all the timber had been harvested, PDIB would burn the area to get rid of the vegetation. For the rest

of April and May, the Emberá would plant rice and other crops while the loggers hauled the timber they had cut out of the forest (Piriati elders).

During the time they lived in Partí, the Emberá looked for other lands where they could establish a permanent community without encroachment and interference from *colonos*. Two families had left the Partí site to settle on the Piriatí River, two kilometers further east, which they considered to have better land (Herrera, unpublished). The community sent a group of men to explore the area. They found an adequate site of virgin forest further upriver on the Piriatí River, closer to the Pan-American Highway. The community leaders informed the PDIB relocation team that they wished to move to Piriatí, and they agreed to prepare the site for the following year (Piriatí elders).

PDIB promised to clear the land where the houses would be built, and more importantly, promised that the nearby *colonos* would be compensated and forced to leave. Four *colono* families were evicted from a site upriver from where the village was to be formed. Another *colono* family lived in Curti, and their land was also expropriated. When the Emberá arrived in Piriati in 1977, the closest *colono* was an hour and a half away, where he still lives.

1976-1977: Settlement of Piriatí

Establishment of the Bayano Corporation

Between 1973 and 1975, PDIB remained dependent on funds from various government ministries for its operations. In addition to the relocation and forestry programs, PDIB planners were making ambitious agricultural development plans in the Lower Bayano (the area of the

watershed below the dam) (Wali, 1989). To carry out the work, they envisioned a financially autonomous state-run regional development agency, akin to the Tennessee Valley Authority in the United States (Herrera, unpublished). In 1976, PDIB was officially expanded into a State Corporation, named the Corporation for the Integrated Development of the Bayano, hereby abbreviated to the Bayano Corporation (Ley No.93 del 22 de diciembre, 1976) (Wali, 1989).

MOVE TO PIRIATÍ

In early 1977, most of the Emberá living in Partí moved to Piriatí (Wali, 1989). They arrived at the chosen site via a logging road that had not been there the year before (Piriatí elders). As they entered the community, they passed a large storage patio with high stacks of *espave* logs. As requested, the Bayano Corporation had cleared an area for building the houses. However, they also seem to have taken advantage of the opportunity to harvest all the timber from the surrounding area. According to one of the men who had been on the original scouting trip, the forest had clearly been logged since he had last been there, and most of the large trees were gone (Piriatí elder).

The Bayano Corporation loggers were evidently looking for fine wood, such as *cedro amargo*, *cedro espino*, *caoba* and *roble*, and not low-value varieties such as *espave* (former logging camp Director). They selectively harvested from most of the Piriatí area, except the southern section of the community where the Pan-American Highway crosses today, because there were no high-value species there (former logging camp Director). They did not even haul away the *espave* logs they had cut, leaving them to rot on the patio (Piriatí elders).

The Emberá were traditionally not involved in the wood business, and they did not understand that they were losing a valuable resource (Piriatí elders). They were generally indifferent to the logging activities that happened before they arrived. They did not even make use of the *espave* that had been left there, because none of the community members knew what to do with it (Piriatí elders).

1980s

Concessionaries

Through the 1980s, the Bayano Corporation decreased its own lumbering activities and increasingly contracted out concessions to small, independent logging outfits (Wali, 1989). By 1985, 39 such companies with over 100,000 Ha' of forestry concessions were operating in eastern Panamá Province, but very little is known about them (Rojas, 1985, p. 219). Many of the concessionaries that operated in the Bayano region during the 1980s were the same logging companies that were brought in by PDIB to carry out the deforestation in 1973-1974.

Three types of concessions were granted, depending on the size of the outfit. For small-scale loggers, 2000-hectare concessions were granted for five years. For medium scale loggers with some milling capacity, 5000-hectare concessions were granted for five years. For large scale, industrial logging companies, concessions were granted for 10,000 hectares and eight years (Conte, 1981, p. 27-28).

LALO RODRIGUEZ

One independent outfit named Lubricantes S.A. was given a 2000 hectare concession in the area of Piriatí, and operated there for three years beginning in 1981 or 1982 (Piriatí elder). The concession extended from Catrigandí to Partí, and all the way to the lake (Piriatí elder). The northern limit is not known precisely. It was owned by Jose Venancio "Lalo" Rodriguez, and operated with five employees, three of whom were from the community. They worked in two teams of two, plus one tractor driver.

According to two community elders who worked as lumberjacks for Rodriguez's company, the Bayano Corporation had already extracted all of the valuable timber trees, so they mostly harvested *espave.* There was still some *roble* and *amargo amargo* left in the forest, but very little. "For every 15 trees, 12 or 13 were *espave,*" because that is all that was left (former lumberjacks).

Each of the teams was contracted to harvest 300 trees per year, but they could make B/ 5 extra for each additional tree. Each team cut roughly 700 trees per year, for a total of 1400 per year, or 4200 trees over three years. According to the terms of the concession, Lubricantes S.A. paid the community $3 for every tree cut (Hermer Barigon, Reinerio Garabato).

ESTIMATING TIMBER EXTRACTION

One of the study objectives was to quantitatively estimate timber extraction, using the data that came from the literature, the interviews, and document search. In this section I outline the results, and in the discussion I explain why the results are not valid.

APPROACH

To estimate how much timber was extracted from the Bayano region during the 1970s, I first establish a theoretical maximum based on estimates of limiting factors such as the potential geographic extent of logging, and the total potential timber volume in the forest. Second, I compare data from the literature to estimate the number of commercially harvestable timber trees/logs per hectare, and compare it with the total number of large trees per hectare to estimate. I assembled all of the available estimates of annual timber extraction during the 1970s in the Bayano and compared them to each other and the results of my calculations. Finally, I conclude with an approximate quantity of timber extracted from the forest during the 1970s.

POTENTIAL TIMBER VOLUME IN THE BAYANO FOREST

Conte (1981) gives a surprisingly precise estimate of the potential timber volume of the Bayano region's forests, claiming that the area potentially had 4,000,098 cubic meters of commercial timber, and 17,000,677 cubic meters of non-commercial timber. Using the Doyle log scale[2], that volume corresponds to 1,695,241,532 board ft. of commercial timber and 7,204,886,913 board ft. of non-commercial timber. If accurate, it would mean that roughly 19% of wood volume in the Bayano forest was of commercial value. However, Conte does not cite or explain how the figure was obtained or calculated.

[2] There are a number of formulas, called log scales, used in the lumber industry to determine the timber volume of a log based on its diameter and/or length. In Panama the most common log scale is the Doyle Scale. The formula is:

$$\text{Volume} = ((\text{Diameter}-4)^2 * \text{Length})/16$$

Using the Doyle Scale, there are 423.8 board ft. per cubic meter.

TIMBER VOLUME AND NUMBER OF TREES PER HECTARE

To test whether Conte's (1981) estimate of total timber volume in the Bayano forest is reliable, I compare it with an estimate of 44.34 cubic meters per hectare (18,791.3 board feet per hectare) of commercial timber in the Bayano region by the Louis Berger Group (1998). Although the forest in 1998 was very different than it was in the 1970s, it provides a useful reference figure to see if Conte's figure is reasonable.

Unfortunately, it is unclear whether Conte's estimate refers to the entire Upper Bayano region, or only the areas that would be feasible to log commercially. Only taking into account topography, I estimate that logging would have only been feasible on 146,420 hectares (approximately 40% of the entire Upper Bayano area). Accounting for rivers, soils, and other local features of the landscape would likely reduce that figure considerably; therefore the estimate can be considered a very conservative maximum. Commercial, non-commercial, and total timber volume per hectare is given in Table for both the entire Upper Bayano as well as the flat area only. The figure of 11,578 board ft. of commercial timber per hectare corresponds more closely with the Louis Berger Group's (1998) estimate, suggesting that the estimate was for the flat, commercially viable area only.

The reliability of that assumption is improved by corroborating the estimate of 60,785 board ft. of total timber per hectare with another source. Data are available on the number of trees above 50 cm DBH found in ten plots of non-intervened primary forest within the Upper Bayano region. The unpublished data are from an ongoing study in Dr. Potvin's lab led by Javier Mateo Vega on forest carbon storage in the Kuna Comarca Madugandi, which falls within the

study area. In the 10 primary forest plots, there are 28.8 trees per hectare on average. This figure can be used as a proxy for the average density of large trees in a primary forest before the 1970s. According to an ANAM Forestry Engineer at ANAM, trees over 50 cm DBH should yield at least 2,000 board ft. per tree on average[3]. Therefore, multiplying 28.8 trees by 2,000 board ft. per tree, one would expect the total timber per hectare to be at least 57,600 board ft., which supports the assumption that Conte's estimate of total potential timber volume referred to commercially harvestable timber only.

Estimates of Annual Extraction in the 1970s

The available information on timber extraction is divided into two periods: the clear-cut effort in 1974-1975, and annual production from selective logging from 1976-1979.

Production would have been highest in 1974 and 1975 when the large clear-cutting effort was underway. Between 1974 and 1976, the Bayano Corporation sold over 21.1 million board ft. of lumber, including 4.4 million board ft. which were exported to Cuba (Conte, 1981). They also sold the equivalent of 430,000 board ft. of material for the fabrication of plywood (Conte, 1981). However, only 8 million board ft. was directly from the clear-cut area (Wali, 1989), which suggests that roughly 13 million board ft. came from selective logging during that time. This data should be reliable because harvested timber it had to be accounted for when it was sold.

3 The Bayano Corporation was focusing on larger species such as *cedro espino* and *espave*. According to the Forestry Engineer, the two species generally yield an average of 3500 and 4000 board ft., respectively.

The most detailed source of data for the volume of harvested timber in the years after the clear-cutting is a document published by the Bayano Corporation itself in 1982, and includes data on timber volume extracted in 1980. According to the document, in 1980 the corporation itself harvested 3.48 million board ft. and private concessionaries harvested 2.52 million, for a total of 6 million board ft. (Table). For the timber harvested by the corporation itself, 72.1% by volume was fine timber, 25.5% was structural timber, and 2.4% was framing timber (Table). However, several different data sources suggest that 6 million board ft. is likely an underestimate.

First, the former forestry camp Director for the Bayano Corporation estimated that average annual production was 8 million board ft.

Second, Gonzalez & Marcucci's (1981) joint-thesis in Public Administration focused on the employees of the Bayano Corporation, and they had direct access to the Corporation's internal accounting ledgers. They report that timber extraction in 1977-78 was 7.5 million board ft. (Gonzalez & Marcucci, 1981).

Third, CEAMM processed roughly 2 million board ft. in 1980 (Figure) (Bayano Corporation, 1982). According to the former Director who was in charge at the time, CEAMM processed between 15-20% of the Bayano Corporation's total output, implying that the total extraction would be 10 to 13 million board ft. that year.

Fourth, according to a Forestry Engineer at ANAM, the highest timber production in the history of the Bayano was 14 million board ft., which took place sometime during the mid-1970s. It is not clear whether it was during the deforestation effort or after.

Therefore, I conclude that annual timber extraction in the years after the clear-cut was more likely 8 million board ft. on average or higher, or 24 million board feet total between 1977 and 1979).

Estimating Timber Extraction: Conclusion

I therefore conclude that the total volume of timber harvest in the 1970s was approximately **45 million board ft.** (21.1 million between 1974 and 1976, and roughly 24 million between 1977 and 1979). Of that total, **37 million board ft. was from selective logging**. At 2000 board ft. per tree, that corresponds to **22,500 total trees**, of which **18,500 were from selective logging**. This corresponds to only 2.7% of the total commercial timber and 0.6% of the total timber volume in the forest, using Conte's figures.

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DISCUSSION

The Bayano region has undergone dramatic LUCC since the 1970s, including a substantial loss of primary forest. The objective of the study was to document historically, geographically, and quantitatively the timber extraction in the Bayano region during the 1970s, to assess the direct and indirect impact it had on the forest and subsequent LUCC.

I draw on literature from other parts of the world to discuss some potential impacts of selective logging on LUCC, and assess the underlying ways in which the selective logging in the Bayano during the 1970s contributed to the LUCC patterns that go on to this day.

IMPACTS OF LOGGING ON SUBSEQUENT LUCC

The legacy of the 1970s timber extraction on subsequent LUCC was primarily from selective logging that occurred after 1975. Before then, much of the timber extraction was in the area that is now flooded, so the long-term impact on land cover was negligible. However, in 1975, the government expanded its selective logging activities and penetrated eastward well beyond the limits of the reservoir. Nevertheless, the total volume extracted is quite low with respect to the entire forest. According to the estimate of total timber extraction, only 0.6% of the total timber volume in the Bayano region's commercially harvestable forest was extracted by logging in the 1970s. Therefore timber extraction was likely not the proximate cause of the dramatic LUCC that has occurred since then.

Instead, the impact of selective logging on subsequent LUCC follows the model of *invasive forest mobility* (Walker, 1993), wherein shifting cultivators and pastoralists independently follow roads opened for selective logging to farm the cutover tracts. Once soil fertility is depleted, the farmers move to other cutover areas, continuing the cycle. This has been extensively documented in the Amazon basin (Asner et al., 2006; Broadbent et al., 2008), Central Africa (Makana & Thomas, 2006), and elsewhere.

According to the model, the primary way in which selective logging leads to deforestation is by opening logging roads. Large-scale selective logging requires an extensive network of logging roads that penetrate deep into the forest, because the spatial distribution of tree species can be highly heterogeneous. For example the number of trees in the research plots in Madugandi ranges from 21 to 35 per hectare. According to a Forestry Engineer at ANAM, in the Bayano there are often large swaths of forest with no commercial timber whatsoever.

The *invasive forest mobility* model generally assumes that the forest degradation is caused by the unsustainable practices of the farmers, and does not take into account the impact of the selective logging itself on LUCC. Due to the spatial heterogeneity of the forest discussed above, selective logging may have strong local effects on LUCC in the areas that are logged.

First, selective logging may impact subsequent land management decisions by making it easier to clear the forest for agriculture, or by making the forest less valuable to local communities. For example, it is easier to burn a selectively logged forest (Matricardi et al.,

2010). Also, impacted forests provide fewer ecosystem services that may incentivize local farmers to protect the forest. For instance, selectively logged forests have fewer game animals (Guariguata & Dupuy, 1997), so local communities may not value it as highly. Aponte (2005) shows how in Venezuela, even mild fragmentation from selective logging can lead to more extensive and land-degrading swidden-fallow agricultural practices. In the Brazilian Amazon, selectively logged forests were four times more likely to be deforested within four years than non-logged forest (Asner et al., 2006)

Second, selective logging disturbs the forest ecology. Removing large trees may allow for increased competition from invasive species (de Mexico, 2011). Fragmentation from logging roads has been shown to degrade soil and affect seedling recruitment in Costa Rica (Guariguata & Dupuy, 1997). In the Amazon, even mild canopy removal from selective logging has significant and long-lasting effects on forest phenology (Koltunov et al., 2009). These effects may create feedback effects that lead to long-term degradation of the forest.

LIMITS

DATA RELIABILITY AND QUALITY

Due to a lack of archiving within government institutions and perhaps foul play, it was very difficult to obtain reliable original documents from the 1970s. For example, I was not able to find any original field logs or other internal documents from the Bayano Corporation. In many cases the secondary sources contradicted one another, and it was impossible to judge which source was more accurate. In other cases, such as the estimate of potential timber

volume in Conte's (1981) thesis, the method or source of the estimate was not explained, and there was no other source to directly corroborate it.

The research therefore depended heavily on interviews, which was also problematic. Unsurprisingly, many respondents had trouble remembering events that happened roughly 40 years ago, particularly with respect to quantitative details. Interviewees also had a range of educational backgrounds and institutional affiliations, which affected the reliability of their responses. For example, former employees of the Bayano Corporation, particularly those who held high-ranking positions, may have had personal incentives to not share certain information that might compromise them. In Piriatí, many of the elders were not accustomed to thinking in terms of absolute numbers and dates, but could only explain things in relative or vague terms.

Another challenge was the fact that the logging activities in the Bayano during the 1970s are historically anomalous, making it difficult to compare the results against studies in other areas. As the government entity changed from PBID to the Bayano Corporation, bureaucratic decisions undoubtedly affected logging logistics; loggers faced a set of unique pressures and were not able to operate as a private logging company would. For example there was no set geographic boundary for where to log, as in a typical forestry concession. They also faced unpredictable patterns of spontaneous *colono* settlement which disrupted logging plans (Former Logging Camp Director for the Bayano Coproation).

One of the key limits of this study was the fact that I could not determine with precision where more of the logging camps and logging roads were. This would have allowed me to focus my study geographically, and compare regional and local-scale effects. It would have also

allowed me to make a much more precise, and possibly more accurate, quantitative assessment of total extraction.

Another key limit was the inability to interview the owners of the private concessions. Many of them may still be alive, but none of them live in the Bayano area and I was not able to contact any of them directly.

CONCLUSION

To my knowledge, this is the first attempt to historically, geographically, and quantitatively document timber extraction in the Bayano during the 1970s, and link it to subsequent land change patterns until the present. This study is timely because due to the scarcity of original documents and other written materials, much of the information about this crucial period in the regions' history only exists in the minds and memories of those who were there.

The logging of the 1970s did not directly cause the deforestation seen in the region today. The areas that were deforested by logging are now under water. The long-term impact on the land-use/land cover of the areas that are above water was therefore from selective logging, mostly after 1975. The penetration of logging roads throughout the primary forest allowed incoming *colonos* to settle in otherwise inaccessible areas, leading to extensive agriculture and cattle ranching, and therefore widespread deforestation. The expansion of the Pan-American Highway may have allowed *colonos* to enter the area, but the network of logging roads allowed them to spread out and have a bigger impact. Further, because of the heterogeneous nature of selective logging, the subsequent deforestation caused forest fragmentation, thus leading to more degradation and deforestation. In other words, selective logging created a cycle of degradation, supporting Sloan's idea of LUCC "pathways" (Sloan, 2007).

The impacts of selective logging on subsequent LUCC are strongest in areas that are directly impacted. One of the key limits of this study was the inability to precisely identify which

areas were directly impacted, and which were indirectly impacted. In the case of Piriatí however, I found that the area surrounding the community was indeed directly impacted by selective logging. Hopefully this finding may inform the ongoing research of Divya Sharma to better understand the subsequent patterns of LUCC in the community.

The findings from this research have implications for selective logging projects beyond the Bayano region. The sustainability of a selective logging operation depends on more than just the regeneration rate of the forest, but also the indirect impacts it may have on subsequent land use decisions by forest dwellers and incoming farmers.

SUGGESTIONS FOR FUTURE RESEARCH

There are a number of opportunities to carry this research forward. The most direct way to build directly on this project would be to find concessionaries who operated in the Bayano during the 1970s or 1980s. Many of them may live in the interior provinces of western Panama, but for lack of resources and time I was not able to reach any of them. If just one of them can be reached, he may be able to provide contacts for several others.

Another possible study would be to analyze the economic impact of the logging. The quantity of timber removed from the forest may seem small compared to the total volume of wood in the forest, but it was focused on removing the most valuable hardwoods. The loss of this resource is likely very high in economic terms. This would be particularly interesting for indigenous communities such as Piriatí, to whom the government promised virgin territory when they were displaced by the dam.

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APPENDIX

APPENDIX 1: TABLES

Forestry management classification	Area (Ha')
To be flooded	35,000
Commercial forests with high high hills (steep terrain, or altitude above 600 meters	103, 926
Commercial forests with low hills	37,688
Commercial forests on "terrace" terrain (river plains and alluvial soils)	49,823
Non-commercial forest	17,313
Protected forest (bordering rivers or the reservoir)	62,512

Table 1: Forest Area in the Upper Bayano, according to the Bayano Corporation's management classifications. Source: Conte, 1981.

Interviewee	Number
Elders in Piriatí	5
Elders in Ipetí-Emberá	2
ANAM Forestry Engineers	3
Social scientists who participated in the relocation effort	3
Colono in Ipetí-Colono	1
Former Director of a Forestry Camp for the Bayano Corporation	1
Former Director of the Bayano Corporation's CEAMM sawmill	1
Former lumberjack for the Bayano Corporation	1
Former worker at the CEAMM sawmill	1
Former administrative secretary for the Bayano Corporation	1

Table 2: List of interviewees

Tool	Quantity used
Saw	250
Axe	7800
Machete	4800
Chainsaw	20

Table 3: Tools bought by PDIB to carry out 1974 deforestation. Source: Conte, 1981 (page 21).

	Lumber caterogy	Logs	Board feet	%	% TOTAL
Bayano Corp.	Framing*	121	84,371	2.42	
	Structural**	4178	887,221	25.49	
	Fine***	5932	2,508,568	72.09	
	Total Bayano Corp.	**10231**	**3,480,160**	**100**	**58**
Concesionario	**Total Concesionario**		2,520,000		42
	Total		**6,000,160**		**100**

Table 4: Timber extraction from Bayano watershed in 1980. Source: Bayano Corporation, 1982

Timber category	Common name in Panama	Scientific name
Framing	Espave	*Anacardium excelsum*
	Corotu	*Enterolobium cyclocarpum*
Structural	Amargo amargo	*Vatairea sp.*
	Amarillo Guayaquil	*Centrolobium yavizanum*
	Amarillo	*Terminalia sp.*
	Panamá	*Sterculia apetala*
	Sigua	*Nectandra sp.*
	Cabimo	*Copaifera aromatica*
	María	*Calophyllum brasiliense*
	Pino amarillo	*Pithecellobium manganese*
	Cedro espino	*Pachira quinata*
Fine	Cedro amargo	*Cedrela odorata*
	Cedro vateo	*Carapa sp.*
	Roble	*Tabebuia pentaphylla*
	Caoba	*Swietenia macrophylla*

Table 5: Species list compiled from Bayano Corporation (1982) and Conte (1981).

	Hectares	Commercial timber per hectare	Non-commercial timber per hectare	Total timber per hectare
Upper bayano	365200	4641	19728	24371
Flat area	146420	11578	49207	60785

Table 6: Timber per hectare calculations based on Conte (1981)

APPENDIX 2: FIGURES

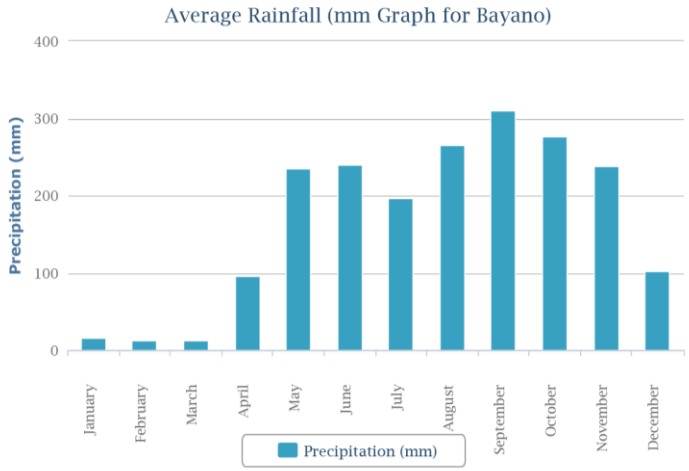
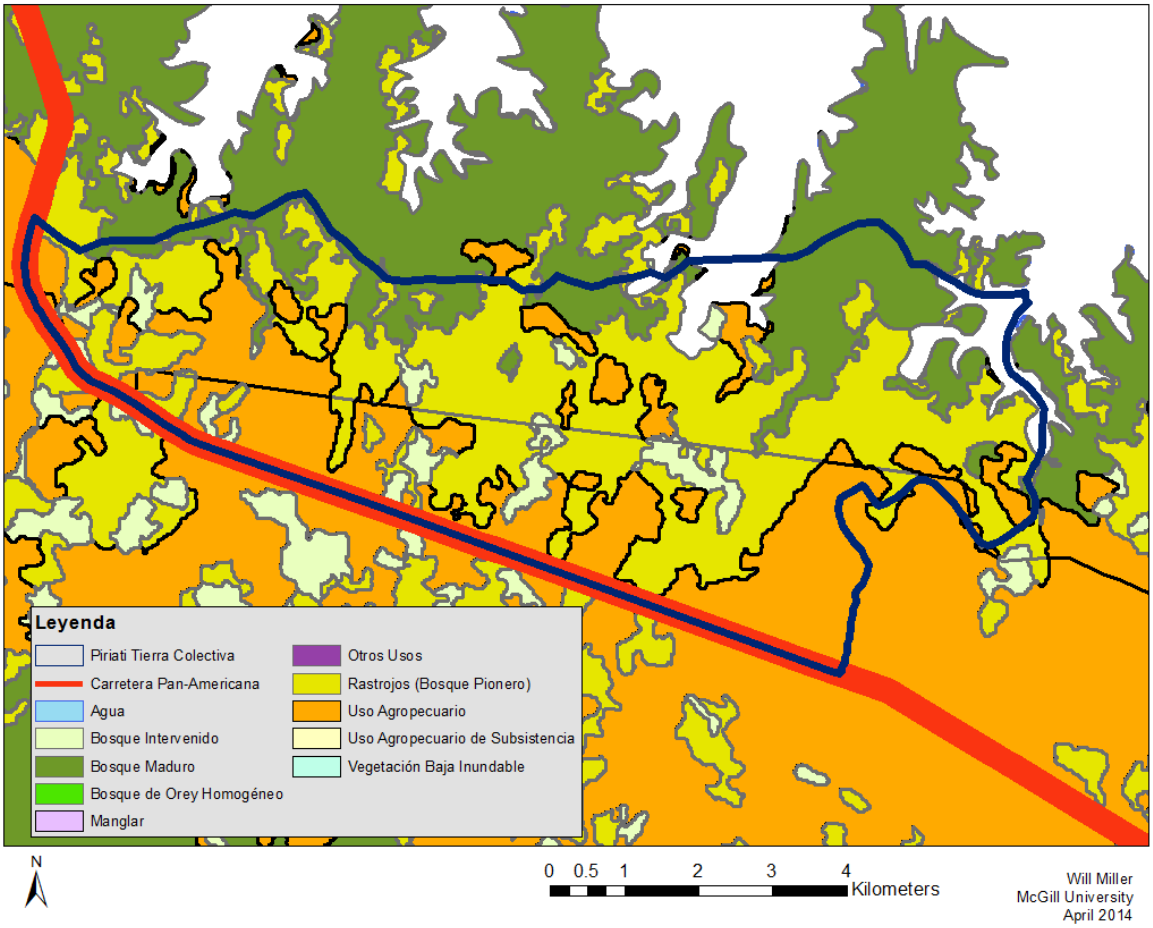
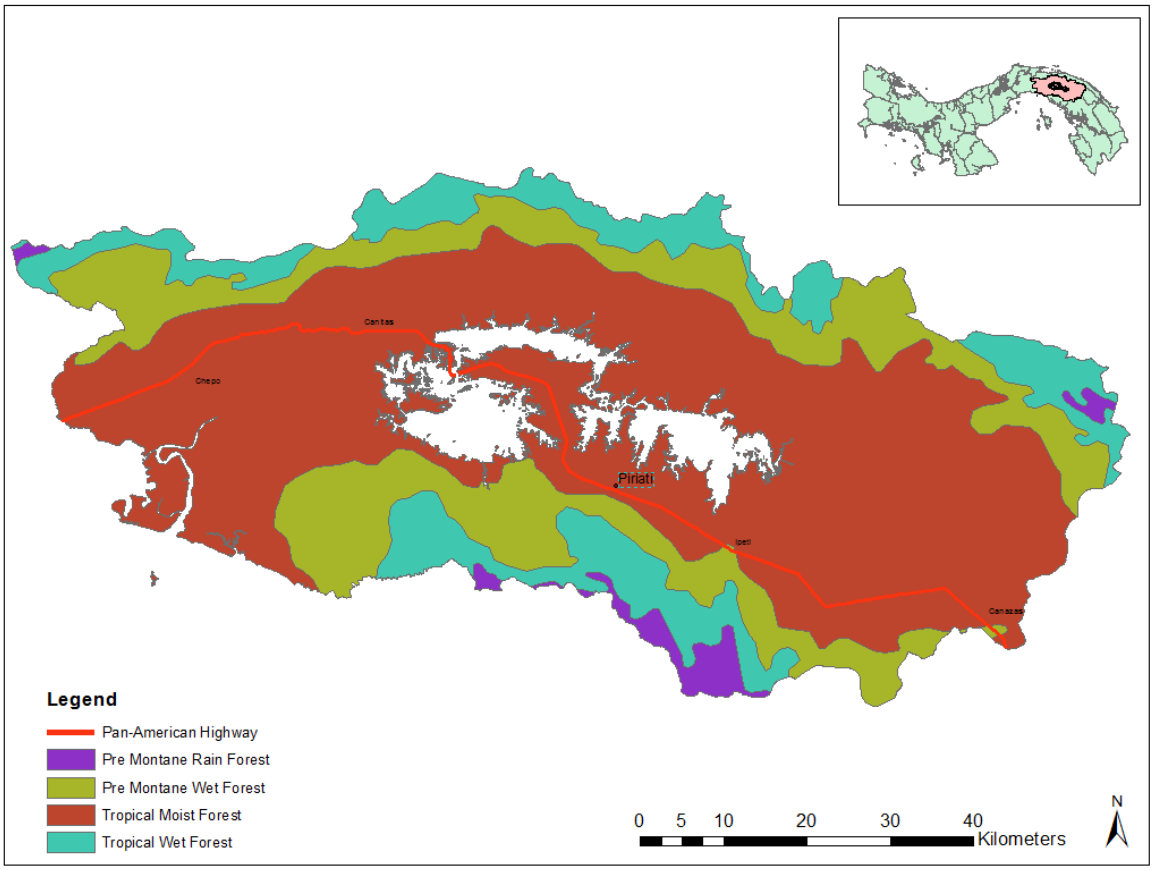


Figure 1: Average Monthly Rainfall in the Upper Bayano Watershed. Source: World Weather Online

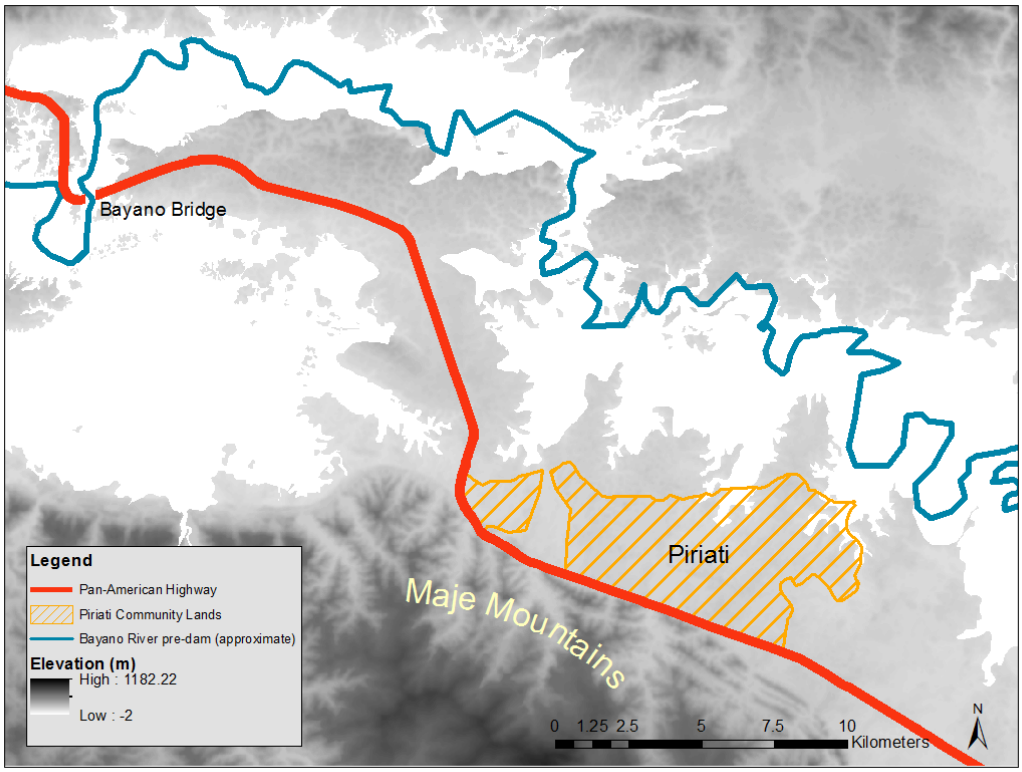
APPENDIX 3: MAPS



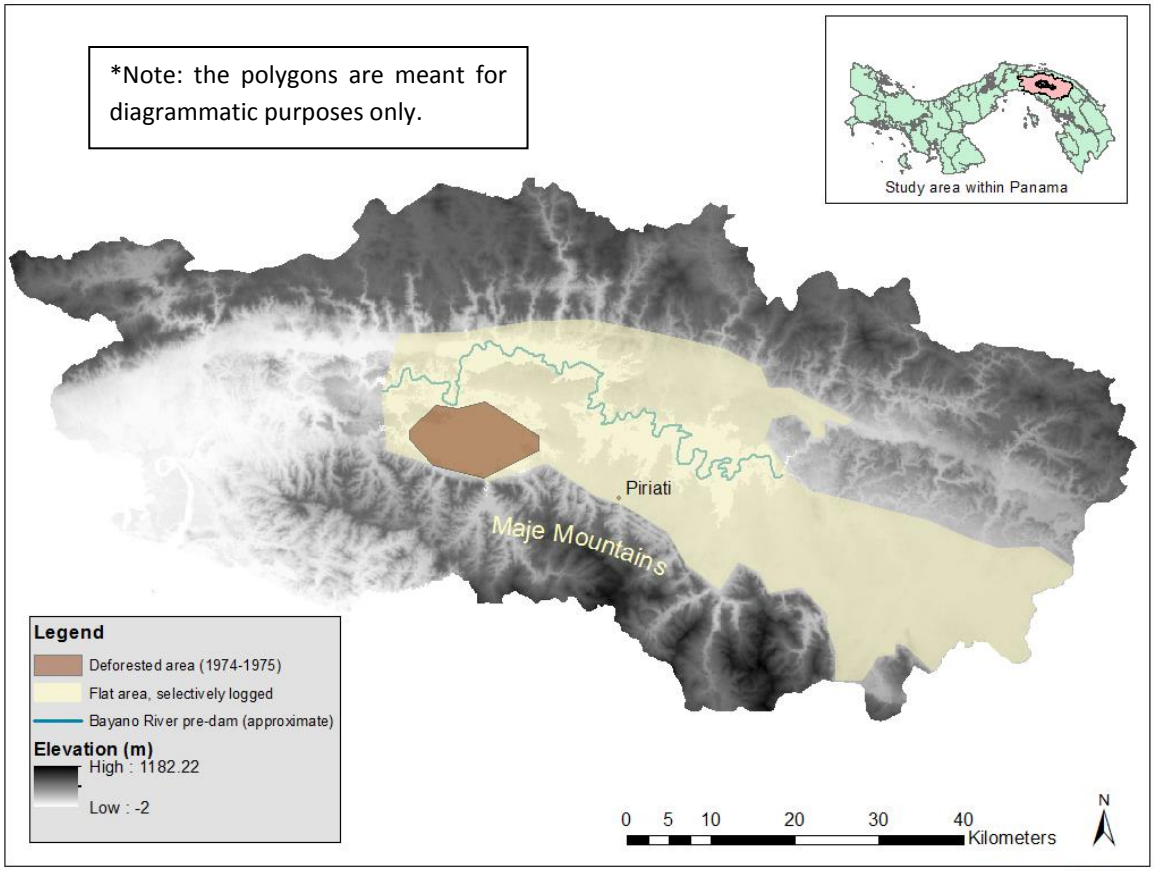
Map 1: Land-cover/Land-use in Piriatí *Tierra Colectiva.* Data source: STRI Library



Map 2: Holdridge Life Zones in the Bayano Region. Data source: STRI Library



Map 3: Location of Maje Mountains with respect to Piriatí



Map 4 : Diagrammatic representation of deforested and selectively logged areas

APPENDIX 4: PHOTOS

Photo 1: Bulldozer crossing the Bayano River in the dry season, February 1974. Source: Bob Webb, 2008.

Photos 2 and 3: Removing logs from the river (left), and loading them onto a truck (right), in February 1973. Source: Bob Webb, 2008.

Photo 4: The Department of National Heritage team, led by Reina Torres de Arauz, meeting with leaders from the *Reserva Cuna de Bayano* and the Emberá community of Majecito. Source: de Arauz et al., 1973.

Photos 5: The Bayano Bridge under construction in December, 1973. Source: Bob Webb, 2008

Photo 6: Truck carrying lumber from near the Bayano River during the clear-cutting effort, 1974. Source: GECU, 1974.

Photo 7: Smoke drifts across road used to contain the controlled fire, which is burning off-screen to the left. Source: GECU, 1974

Photo 8: Signing the relocation agreement *Acuerdo de Majecito* between leaders of Majecito and Bayano Project representatives. Source: Pastor, 1985.

APPENDIX 5: SOURCE CRITICISM SEVEN-STEP METHOD

1. If the sources all agree about an event, historians can consider the event proved.

2. However, majority does not rule; even if most sources relate events in one way, that version will not prevail unless it passes the test of critical textual analysis[4].

3. The source whose account can be confirmed by reference to outside authorities in some of its parts can be trusted in its entirety if it is impossible similarly to confirm the entire text.

4. When two sources disagree on a particular point, the historian will prefer the source with most "authority"—that is the source created by the expert or by the eyewitness.

5. Eyewitnesses are, in general, to be preferred especially in circumstances where the ordinary observer could have accurately reported what transpired and, more specifically, when they deal with facts known by most contemporaries.

6. If two independently created sources agree on a matter, the reliability of each is measurably enhanced.

7. When two sources disagree and there is no other means of evaluation, then historians take the source which seems to accord best with common sense.

Source: Langlois & Seignobos, 1900

[4] Critical textual analysis may be considered an academic precursor to Critical Discourse Analysis (CDA). I interpret the "test of critical textual analysis" to mean a critical examination of the socio-political context of the source and its place within the broader discourse it engaged with, including potential power dynamics and the embedded assumptions of the author or authors.