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Contributions of local floodplain resources to livelihoods and household income in the Peruvian Amazon

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ABSTRACT

This paper highlights the economic contributions of natural resources to rural livelihoods and represents one of the first comprehensive income quantifications assessing household- and landscape-level determinants of resource use in the Amazon. Income data (n = 176) collected over one year quantified all subsistence and cash income generated by indigenous and non-indigenous residents in two locations within the Ampiyacu–Apayacu basin. Products harvested from unmanaged forests and agroforests contributed 42% of household income, while fishing contributed 14%, resulting in over 55% of household income derived from local resources. Poorer households are most reliant on forest products, particularly low value resources, while wealthier households benefit more from commercial harvest. Tobit regression analyses and general linearized models identified key determinants of (i) resource harvest engagement and (ii) absolute and relative incomes derived from natural resources. Basin location (East versus West), ethnic identification, distance to market/forest proximity, household wealth and access to non-farm/forest cash income sources were all significant. These determinants varied, however, depending on the specific resource harvested (e.g. palm heart versus timber). This relates to i) varying abundance of individual resources across the landscape, and ii) differences in harvest purpose (subsistence versus sale) and product type (low-value/low-return versus high-value/high return). Future policies and initiatives should promote the conservation and sustainable use of diverse environments which are critical to livelihoods (e.g., forests, palm swamps, agroforests, rivers and lakes).

1. Introduction

Nearly half the world's rural population relies upon forests for subsistence products or cash income generation (Angelsen and Wunder, 2003). Forests and surrounding environments supply essential nutrients and vitamins, construction and handicraft materials, medicines, marketable products like timber and game, and culturally important resources (Campbell and Luckert, 2002; Vedeld et al., 2004; Shackleton et al., 2011). The considerable cumulative value of these resources has been demonstrated in recent in-depth quantitative surveys throughout the tropics. These studies report forest income reliance figures ranging from 17 to 53% of total household income (Godoy et al., 2002; Fisher, 2004; Babulo et al., 2008; Heubach et al., 2011; Tesfaye et al., 2011), with somewhat lower contributions in low forest cover sites (e.g. 7–19% in Malawi (Kamanga et al., 2009)). Recent quantifications in the Amazon report forest shares as high as 39% (Peru) , 42% (Brazil) and 63% (Bolivia) (Duchelle et al., 2011; Porro et al., 2015), and shares as low as 20% and 8%, elsewhere in Bolivia and Peru, respectively (Barham et al., 1999; Uberhuaga et al., 2012). These wide-ranging reports highlight the varying importance of forest products across the region, and the need for more case studies.

In the Amazon, ethnobotanical and other cultural aspects of wild and cultivated forest product use (Jensen and Balslev, 1995; Macía, 2004; Vandebroek et al., 2004; Reyes-García et al., 2006) have received greater attention than the economic contributions of natural resources (Barham et al., 1999; Coomes et al., 2004; Gavin and Anderson, 2007). Moreover, the bulk of recent research quantifying forest income has focused on the economic values of a few highly marketed products (Muñiz-Miret et al., 1996; Coomes, 2004; Manzi and Coomes, 2009), overshadowing subsistence roles.

Incomes from natural environments outside forests can be substantial (Uberhuaga et al., 2012), and sometimes higher than those derived from forests (Pouliot and Treue, 2012). However, the relative importance of specific environments is not well-documented. Most Amazonian income and natural resource-based livelihood studies have separately addressed i) homegarden cultivation (Padoch and Jong, 1991; Coomes and Ban, 2004), ii) fallow production (Hammond et al., 1995; De Jong, 2001; Toledo and Salick, 2005) or iii) forest product harvest (Takasaki et al., 2001; Godoy et al., 2002; Escobal and Aldana, 2003), rather than being all-inclusive. A few notable exceptions in the recent literature incorporate products from all environments (Coomes et al., 2004; Uberhuaga et al., 2012; Zenteno et al., 2012; Porro et al.,

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2015). However, the authors focus on broad product categories and do not discriminate the specific environments from which products are harvested. The distinction of income generated from unmanaged, old-growth forest sites versus managed, regenerating secondary forests (fallows) is particularly important in the Amazon, where the latter are widespread. Fallows and mature forests each possess unique biophysical and cultural characteristics, harboring many products adapted to and/or harvested from only one environment (Fujisaka et al., 2000).

In addition, a body of knowledge has accumulated regarding household- and landscape-level determinants of natural resource harvest. For example, age and education (McSweeney, 2005; Fisher et al., 2010), ethnicity (Heubach et al., 2011; Porro et al., 2015), available household labor (Hegde and Enters, 2000; Fisher, 2004), skills and capital (Coomes et al., 2004), proximity to natural resources or markets (Takasaki et al., 2010; Porro et al., 2015) and product type (high- versus low-value) (Fisher, 2004; Narain et al., 2008) have all be shown to influence household reliance on forest and other resources (examples cited in Table 1). However, few of these studies encompass all harvested environments or differentiate cash and subsistence incomes over an entire year. To develop socio-culturally- and economically-appropriate policies which achieve both biological conservation and improved livelihoods, further in-depth data are needed regarding resource reliance and its determinants. This study seeks to address some of the outlined gaps by examining the economic importance of major and minor products from forests, as well as other natural environments, and how the use and dependence on these resources is related to a range of variables at household and landscape levels.

The Ampiyacu–Apayacu basin, in Loreto, Peru, provides a favorable setting to assess local resource values and factors influencing harvest in a dynamic floodplain forest environment. The basin's forest mosaic plays a key role in livelihood security and poverty reduction for approximately 3000 residents (Pitman et al., 2004). This importance contributed to the creation of the Ampiyacu–Apayacu Regional Conservation Area (AA-RCA) (Fig. 1) in 2010 (SERNANP, 2010). The AA-RCA covers over 400,000 ha of Peruvian lowland terra firme and regularly and seasonally flooded tropical old-growth forest environments interspersed with palm-dominated swamps (*aguajales*) and lakes (Pitman et al., 2004). Residents settled along main waterways are highly reliant upon natural resources in and near the AA-RCA.

This paper addresses the following questions: 1) How do forest and other natural resources contribute to household subsistence and cash incomes? 2) Which households are most dependent upon these resources? 3) Which household and landscape factors influence resource reliance? The study draws on the sustainable livelihoods framework described by the Department for International Development (DFID, 1999) and peasant diversification theory (Ellis, 2000), incorporating Byron and Arnold (1999). The analysis builds on current economic models explaining household income and resource dependency, such as those described by Coomes (1996), Coomes et al. (2004) and Heubach et al. (2011). Natural resource extraction and income reliance are predicted to be influenced by factors such as age, ethnicity, education, wealth, available labor, resource proximity and market access (see Table 1 for predicted variable relationships) and these relationships will vary between specific product categories.

Table 1
Predicted relationships between independent variables and resource use.

Independent variables	Predicted relationships based on previous findings
Age	Natural resource harvest may be greater for younger individuals with little capital or other income alternatives. It may be lower for older individuals that cannot engage in strenuous activities (e.g. timber harvest) (McSweeney, 2005; Fisher et al., 2010), or higher if older individuals gain skills or experience (e.g. hunting) (Coomes et al., 2004).
Ethnicity	Reliance on natural resources differs according to ethnic affiliation (Heubach et al., 2011; Kar and Jacobson, 2012; Porro et al., 2015).
Education	Less educated households are more dependent upon forest income (Stoian, 2005; Fisher et al., 2010).
Dependents	Household dependency ratio is negatively related to forest product income (Quang and Anh, 2006).
Household labor	More household labor relates positively to extractive income (Hegde and Enters, 2000). This may depend on the product or product value (e.g. male labor correlating with timber or game, female labor correlating with handicrafts or gathered non-timber forest products) (Fisher, 2004; Quang and Anh (2006)).
Wealth	Wealthier households derive higher absolute incomes (Kar and Jacobson, 2012) and poorer households derive higher relative incomes from natural resources (Heubach et al., 2011; Kar and Jacobson, 2012). Wealthier households derive more cash from forest resources (Mahapatra et al., 2005) and can better capitalize on product marketing (Heubach et al., 2011). Asset poor households are more reliant on low return activities (Fisher, 2004).
Market access	Increasing distance from markets increases forest dependency (Masozera and Alavalapati, 2004), particularly for nutritional subsistence products. Forest and other product sale increases near markets (Godoy et al., 2002; Porro et al., 2015).
Forest access	Proximity to forests positively relates to forest product extraction (Fisher and Shively, 2005; Fisher et al., 2010).
Resource type	Reliance on forest income depends on the type of resource harvested (e.g. low value fruits versus high-value timber) (Fisher, 2004; Narain et al., 2008; Abebaw et al., 2012).

2. Methods

2.1. Study population, economic activities and local resource use

The study was carried out in eleven villages situated along three tributaries of the Amazon River (Apayacu, Ampiyacu and Yaguasyacu Rivers), between 3°12′ and 3°30′ South latitude and 71°53′ and 72°27′ West longitude, Loreto, Peru (Fig. 1). The rainy season occurs between December and May, and annual precipitation averages over 2800 mm (Pitman et al., 2004; IBC et al., 2011). Villages are composed of self-identified indigenous and mestizo (of mixed Spanish and Amerindian descent) residents. Surveyed villages are located less than 150 km northeast of Iquitos and all transportation occurs via waterways. Livelihood activities include shifting cultivation, fallow and forest product harvest, handicraft production, fishing and hunting (Vormisto, 2002; Pitman et al., 2004). Activities are dictated by the flood regime, which determines access to harvest sites and markets. Two distinct subpopulations (locations) are identified, hereafter referred to as “East” and “West”. Residents near the eastern reaches of the AA-RCA live along the Ampiyacu and Yaguasyacu Rivers, and the western group along the Apayacu River. The groups differ in ethnic composition, traditional livelihood strategies, flood exposure and resource endowments including forest products and fish stocks (Table 2).

In addition to timber and game, three palm species are especially prominent in local livelihood portfolios, including chambira (*Astrocaryum chambira* Burret), irapay (*Lepidocaryum tenue* Mart.) and aguaje (*Mauritia flexuosa* L.f.). Eastern residents sell handicrafts such as hammocks and shoulder bags, made from chambira fibers, to outside traders, NGOs and government agencies. Irapay leaves constitute the primary material used in affordable roof thatching and aguaje palm fruit represents a key subsistence food and cash generator. Aguaje and irapay are found in relatively undisturbed forest environments, while chambira palms are found abundantly in managed fallows. Regenerating fallows, which result from shifting cultivation, are managed for a diversity of products including manioc, plantain, various fruits, fibers and medicinal plants. In contrast, other products are found abundantly only in unmanaged forests within and near the AA-RCA (e.g., game, timber). Within indigenous lands (titles have been granted to all villages but AP1), residents retain forest use rights for subsistence needs. Commercial use of forest resources requires permits from the forestry authority, though some small-scale sale of products from indigenous territories and surrounds occurs de facto (Espinoza Llanos and Feather, 2011). Within the AA-RCA, subsistence resource harvest is permitted, however harvest quotas for