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Geographic factors predict wild food and nonfood NTFP collection by households across four African countries

Matthew Cooper[a,b,*], Alex Zvoleff[a], Mariano Gonzalez-Roglich[a], Felly Tusiime[c], Mark Musumba[d], Monica Noon[a], Peter Alele[a], Madeleine Nyiratuza[e]

[a] Conservation International, 2011 Crystal Drive #500, Arlington, VA 20222, United States
[b] University of Maryland, Department of Geographical Sciences, 2181 Samuel J. LeFrak Hall, 7251 Preinkert Drive, College Park, MD 20742, United States
[c] Africa Innovations Institute, Plot 1544, Koire Close, Old Kiira Road, Bukoto, Kampala, Uganda
[d] University of Florida, Institute of Food and Agricultural Sciences, P.O. Box 110180, Gainesville, FL 32611-0180, United States
[e] Wildlife Conservation Society, KG 635 St, Kigali, Rwanda

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ABSTRACT

Wild foods and other nonfood NTFPs are important for improving food security and supplementing incomes in rural peoples' livelihoods. However, studies on the importance of NTFPs to rural communities are often limited to a few select sites and are conducted in areas that are already known to have high rates of NTFP use. To address this, we examined the role of geographic and household level variables in determining whether a household would report collecting wild foods and other nonfood NTFP across 25 agro-ecological landscapes in Tanzania, Rwanda, Uganda and Ghana. The aim of this study was to contribute to the literature on NTFP collection in Africa and to better understand where people depend on these resources by drawing on a broad range of sites that were highly variable in geographic characteristics as well as rates of NTFP collection to provide a better understanding of the determinants of NTFP collection. We found that geographic factors, such as the presence of forests, non-forest natural areas like grasslands and shrublands, and lower population density significantly predict whether a household will report collecting NTFP, and that these factors have greater explanatory power than household characteristics

1. Introduction

Ecosystem services are critical to human well-being (Haines-Young and Potschin, 2010). Throughout the world, natural and human-impacted areas provide regulating, cultural and provisioning ecosystem services (Bennett et al., 2009), and non-timber forest products (NTFPs) are a provisioning ecosystem service that supports human livelihoods in both developed and developing countries (Shackleton et al., 2015; Sisak et al., 2016; Živojinović et al., 2017). In agrarian parts of the developing world, communities depend significantly on local provisioning ecosystem services for their health and income (Altieri, 2004; Zenteno et al., 2013). While agricultural production often provides the bulk of food and income in these areas, provisioning ecosystem services from forests, shrublands and grasslands also make significant contributions to communities' livelihoods (Ambrose-Oji, 2003; Heubach et al., 2011; Kar and Jacobson, 2012). Understanding the geographic and demographic characteristics of areas that depend on provisioning services in the form of NTFPs is key to conservation strategies that maximize NTFP availability to support human livelihoods and well-being (Angelsen et al., 2011; Kareiva, 2011).

It has been estimated that NTFPs provide income and nutrition for over two-thirds of Africa's population (CIFOR, 2005). These products provide significant income to households and communities, with some products like shea oil and gum arabic being collected and exported to international markets (Mujawamariya and Karimov, 2014; Rousseau et al., 2017). Many other products, such as fuelwood and building materials, are also sold locally and are an income source. A global literature review of 51 case studies across 17 developing countries estimated that, on average, forests provide 22% of a household's total income (Vedeld et al., 2007). While access to NTFPs is often moderated by political and cultural institutions (Lambini and Nguyen, 2014; Ludvig et al., 2016), a common feature of NTFPs is that they do not require financial capital to procure. Thus, households with less income tend to be the most dependent on forest products for food, fuel and materials (Vedeld et al., 2007).

* Corresponding author at: Conservation International, 2011 Crystal Drive #500, Arlington, VA 20222, United States.
E-mail addresses: mattcoop@terpmail.umd.edu (M. Cooper), azvoleff@conservation.org (A. Zvoleff), mgonzalez-roglich@conservation.org (M. Gonzalez-Roglich), mmusumba@ufl.edu (M. Musumba), mnoon@conservation.org (M. Noon), palele@conservation.org (P. Alele), mnyiratuza@wcs.org (M. Nyiratuza).

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In addition to providing income and supplying goods that households would otherwise have to purchase from markets, NTFPs also support nutrition outcomes, and many wild foods are consumed directly by the household that collected them. Given that forests and other natural areas offer significantly more species for consumption than agriculture alone, wild foods can significantly increase a household's dietary diversity (Powell et al., 2015; Remans and Smukler, 2013) and also provide an income source (Ingram et al., 2017). A study in Madagascar found that removing households' access to wildlife for consumption would increase rates of child anemia by 29% due to decreased meat consumption (Golden et al., 2011). While some wild foods are consumed continuously, many others are a reserve food supply used during times of famine. These "famine foods" are not preferred but are essential for households during hungry seasons or years when agricultural output is low (Mavengahama et al., 2013). Such foods increase household resilience to climate shocks. In surveys of households' climate adaptation strategies in Mali, Tanzania, and Zambia, forests were found to play a key role in reducing vulnerability during droughts and floods by providing alternative food and income sources (Robledo et al., 2012).

While forests are significant providers of NTFP and provisioning ecosystem services, products sourced from other natural areas like shrublands and grasslands also play a significant role in households' livelihoods (Pouliot and Treue, 2013). Because access to forested land is sometimes more regulated than access to grassland and shrubland, these non-forested areas can be a significant resource to less well-connected or less wealthy rural people, such as women or ethnic minorities (Pouliot and Treue, 2013). Whether products sourced from these areas can be included in the term "NTFP" is debatable, as a NTFP can often refer to many types of products sourced from a wide variety of environmental areas and land cover types (Belcher, 2003). For example, some trees that provide products typically classified as NTFPs, such as the Gum Arabic tree (*Senegalia senegal*), often grow in areas with less than the 10% canopy cover required to meet the FAO definition of a forest (FAO, 2012). Furthermore, products sourced from uncultivated non-forest areas have the basic fundamental economic characteristics of NTFPs identified in a comprehensive paper from the Center for International Forestry Research (CIFOR) on NTFPs and rural livelihoods: (i) they have low returns per unit area; (ii) they are primarily used for subsistence and often fill income gaps; and (iii) they are not planted, and are only managed indirectly, if at all (Angelsen and Wunder, 2003). Thus, while this paper examines foods from both forested and non-forested areas like grasslands and shrublands, we use the term NTFP to refer to provisioning ecosystem services sourced from any natural area following the characterization laid out by CIFOR (Angelsen and Wunder, 2003). In our analyses, we split NTFP into two categories: "wild foods" for NTFP like nuts, seeds, bushmeat, honey, or insects, and "nonfood NTFP" for other products such as building materials, medicines, and fibers. When speaking about both wild foods and nonfood NTFP, we use the general term NTFP.

While the benefit that NTFPs provide in supporting rural livelihoods has been clearly demonstrated in many case studies, few studies have been conducted at national and multinational scales relevant to policymakers or conservation and development practitioners (Reed et al., 2016). Indeed, a recent literature review lamented that this body of work is "limited by the propensity for small-scale and short-term evaluations" (Reed et al., 2016). Some notable exceptions to the preponderance of case studies include literature reviews on topics like wild food consumption (Powell et al., 2015) and environmental income from forests (Vedeld et al., 2007), as well as the Population-Environment Network (PEN) dataset on household NTFP use based on surveys conducted in 24 developing countries (Angelsen et al., 2014; Hickey et al., 2016). While these literature reviews and the PEN study have made significant contributions to our understanding of characteristics of households that depend on NTFPs and the degree of their dependence, they have a significant sampling bias, with most of the case studies and sample sites established opportunistically in areas with significant forest cover and where communities were already known to utilize forest resources. Thus, findings from these studies showing that NTFPs provide 22% of total income (Vedeld et al., 2007) or 28% of total income (Angelsen et al., 2014) cannot be taken as representative of all rural developing countries or as representative of any one country.

The fact that studies of household use of NTFPs are usually only conducted in highly localized case studies is unfortunate, as a growing body of literature is beginning to associate various environmental data metrics from satellite imagery with indicators of income, health, and food security from household surveys. Such research has found relationships between an increased Normalized Difference Vegetation Index (NDVI) and decreased child mortality (Brown et al., 2014); more forest cover and greater dietary diversity (Ickowitz et al., 2014); and more forest cover and decreased child stunting (Johnson et al., 2013). Many of these studies have found significant associations, but the specific mechanisms underlying linkages between environmental indicators like NDVI and forest cover with human well-being remain under-explored at relevant scales. This is largely because multinational surveys on human well-being, such as Demographic and Health Surveys (DHS) and Living Standards Measurement Surveys (LSMS), do not collect data on the accessibility and collection of wild foods and nonfood products in a standardized manner across countries. On the other hand, datasets that do include data on NTFP use, such as individual case studies or the PEN dataset, do not include detailed data on key measures of human well-being, such as agricultural production, health, and food security. Thus, datasets that can be used to find a significant relationship between vegetation indices or land cover and human well-being at multinational scales are often lacking data on the exact causal linkages. For example, a recent study showed that forest cover was associated with dietary diversity across 21 African countries (Ickowitz et al., 2014, p. 290), but could not explain the exact linkages, stating:

"while we have found clear evidence linking tree cover and indicators of diet quality, we are not able to determine the drivers of this relationship. Our data do not allow us to distinguish between natural forests, old fallows, and agro-forests; thus we cannot ascertain if people living near forests are collecting more nutritious foods from the forest or if they are cultivating them on farms and in agroforests, or a combination."

This paper aims to bridge these gaps – to provide a characterization of households that gather both food and nonfood NTFP in terms of both household characteristics and environmental characteristics. We do this by examining which geographical and household level variables are significant predictors of household wild food and nonfood gathering from 25 agro-ecological landscapes in 4 countries. While the landscapes in this study were not selected at random, they were selected purposively to monitor a variety of topics such as agricultural intensification, livelihoods, and environmental quality. Thus, landscapes were not selected with the specific intention of examining wild food or NTFP collection, and some of the landscapes selected had no households that reported collecting any NTFPs. This dataset therefore provides a unique opportunity to examine variation in NTFP gathering across and within multiple African countries and agro-ecological regions, as well as the factors associated with that variation, without relying on sample data that was collected in areas already known to have high levels of NTFP gathering. A geographic characterization of households that collect NTFP can, in turn, begin to fill in gaps in knowledge of the mechanisms by which ecosystem provisioning services (measured by satellite-derived environmental indices) could be contributing to positive human health outcomes. Finally, an understanding of which landscapes contain households that collect NTFP in significant numbers can aid conservation priority setting efforts that aim to maximize ecosystem service provision.

2. Methods and data

For household survey data, we used data from the Vital Signs project (Scholes et al., 2013). Vital Signs is an integrated monitoring system that collects data on agriculture, the environment and livelihoods in a number of agricultural landscapes in Africa. The sampling design involves six to