Migration, health and environmental change along the Interoceanic Highway in Peru

William Pan [1]
Richard Bilsborrow [2]
Beth Feingold [3]
Gabriela Salmon-Mulanovich [3,4]
Abel Estela [4]
Andres Lescano [4]
Hugo Razurri [4]
Eric Halsey [4]

1 Duke University
2 University of North Carolina
3 Johns Hopkins University
4 Naval Medical Research Unit-6

Abstract

Anthropogenic environmental change has become increasingly implicated as a key driver of disease transmission. In the Amazon, environmental change occurs most rapidly following road construction. In July 2011, we initiated a population-based study in the southern Peruvian Amzaon to examine the relationship between population-environment changes and human health in 50 urban and rural communities (600 households) near the recently constructed Interoceanic Highway. In this paper we present our initial findings. Data collection is ongoing at the time of this abstract (40% complete), thus our extended abstract describes the study design and expected data to be presented, including TFR, temporary labor migration, household mobility, obesity, blood pressure, and prevalence of malaria, anemia and dengue fever infection. We are particularly interested in the impact of migration and human mobility on the risk of infectious disease as well as dual-burden of infectious and chronic disease that exists in this region.

Background

The conversion of land to agricultural use is the most salient footprint of human existence on earth. This is particularly true in the Amazon Basin, the world's largest rainforest and most bio-diverse region on the planet, where a constant influx of poor settlers, job-seekers, and agri-businessmen, among others, has propelled deforestation to an estimated 4.3 million hectares per year. As research on PHE linkages has matured, more questions have been raised as to the nuances of the relationships. Studies of the human dimensions of environmental change recognize the need to extensively examine human communities and the reciprocal interactions between human populations and the physical environment. Increasingly, the Amazon is populated by migrants from other regions who bring different ideas about how to build an economy, what constitutes resources, and how to organize to exploit it. This creates considerable heterogeneity across human community landscapes, even in relatively small areas. Those from coastal Peru, for example, brought intensive rice production using irrigation to the Amazon, while those from the Andes bring a very different set of production practices.

This study will be conducted in the southern Peruvian Amazon in the department of ***Madre de Dios*** (MDD). MDD is a southeastern region of Peru that contains 15.3% of Peru's forest areas and still has very low population density, with a total population of 106,036 in 2007 [1]. Seventy percent of the

inhabitants are in-migrants, mainly from the neighboring regions of Cusco and Puno. Nonetheless, there are 49 ethno-linguistic groups categorized as native communities and even some populations living in voluntary isolation [2]. Persons living in MDD suffer primarily from respiratory, gastrointestinal and malaria infections, with widespread under-nutrition, particularly in children under 5. Although health burden is spread across several ailments, including leishmaniasis, sylvatic yellow fever, rabies, and parasitic diseases (e.g., *Ascaris*, *Trichuris*, hookwork and *Strongyloides*), the latest report by MoH (December 2010) indicate that malaria cases have already surpassed the total in 2009 and there are already three times more cases of dengue compared to all of 2009. Causes of many of these diseases are related to the rapid environmental changes occurring in MDD, which has an enormous concentration of natural species and is considered one of the world's 7 "hottest hotspots of biodiversity" [3]. As a result, the high incipient deforestation rate is of great concern for ecological conservation and human well-being.

The major driver of environmental change in MDD has been the construction of the Interoceanic Highway, an ongoing project to connect Atlantic and Pacific Ocean ports in Peru and Brazil. The highway is a major thoroughfare for people living near the border of Peru and Brazil, and has led to an increasing rate of resource extraction in the region. Road construction is well-established as a major cause for population mobility, human fertility change, deforestation, urbanization, vector-borne disease risk, and child mortality [4-12]. Rural-rural migration is particularly devastating as increasing population density induces further settlement into forested areas as shown in Ecuador and Peru [7, 8, 13, 14]. These studies depict labor migration as a strategy to diversify risk through cash income with significant gender differentials: women tend to out-migrate to large urban areas and encourage family members to migrate for better access to services, while men tend to new frontier areas. Urbanization of the Amazon is largely unstudied, but highly important to environment and health dynamics [15, 16]. Community context and urban expansion influence a wide array of social and economic factors at both micro (household location of settlement, agricultural practices, household and off-farm labor, fertility decisions, e.g., [17-20]) and macro scales (attraction of large-scale commercial agriculture, industrial investment for resource extraction, e.g., [21-25]). Land-fertility relationships are also strong, with studies demonstrating that in rural environments, when land access increases, fertility tends to rise and, conversely, land ownership suppresses fertility [26][27-30][19, 31, 32]. These arguments are also tied to the land-fertility relationship in rural agricultural frontiers in which labor demand increases childbirth [33] and reduced infrastructure, access to family planning and opportunities for women increases desired family sizes [34-36].

From an ecological perspective, road construction in the Amazon is a prelude to widespread anthropogenic change. More than 75% of deforestation occurs within 25 km of a road [37-40] and nearly every study of Amazonia land use has implicated road or market access as a key factor of land use/land cover change (LULC). A recent study by Lorena and Lambin further demonstrates that roads not only influence deforestation rates, but variable access to infrastructure due to roads influence the spatial pattern of land use and fragmentation [41]. The influence of roads in the Amazon impact health outcomes directly and indirectly through mediation of human exposure to infectious diseases, altering nutritional status and changing health seeking behaviors. Roads have been associated with increases in malaria risk [42-49], expansion of dengue vectors [50], increased incidence of sexually transmitted diseases [51-53] and influencing childhood malnutrition and diarrheal incidence [54-56]. The impact of roads is often bi-directional and time-dependent – i.e., most adverse impacts are felt during initial road construction and migration settlement processes but road and infrastructure improvements may ultimately lead to greater outreach/utilization of social services, poverty reduction, and migration of farmers away from marginal land. However, this transition has been historically slow as settlers are presented with weak land tenure policies, in-migration pressure and poor health, which often results in

a ‘speculative’ frontier where individuals with limited pertinent skills are enticed into settlement areas where they are poorly suited to the laboral activities that must sustain their household.

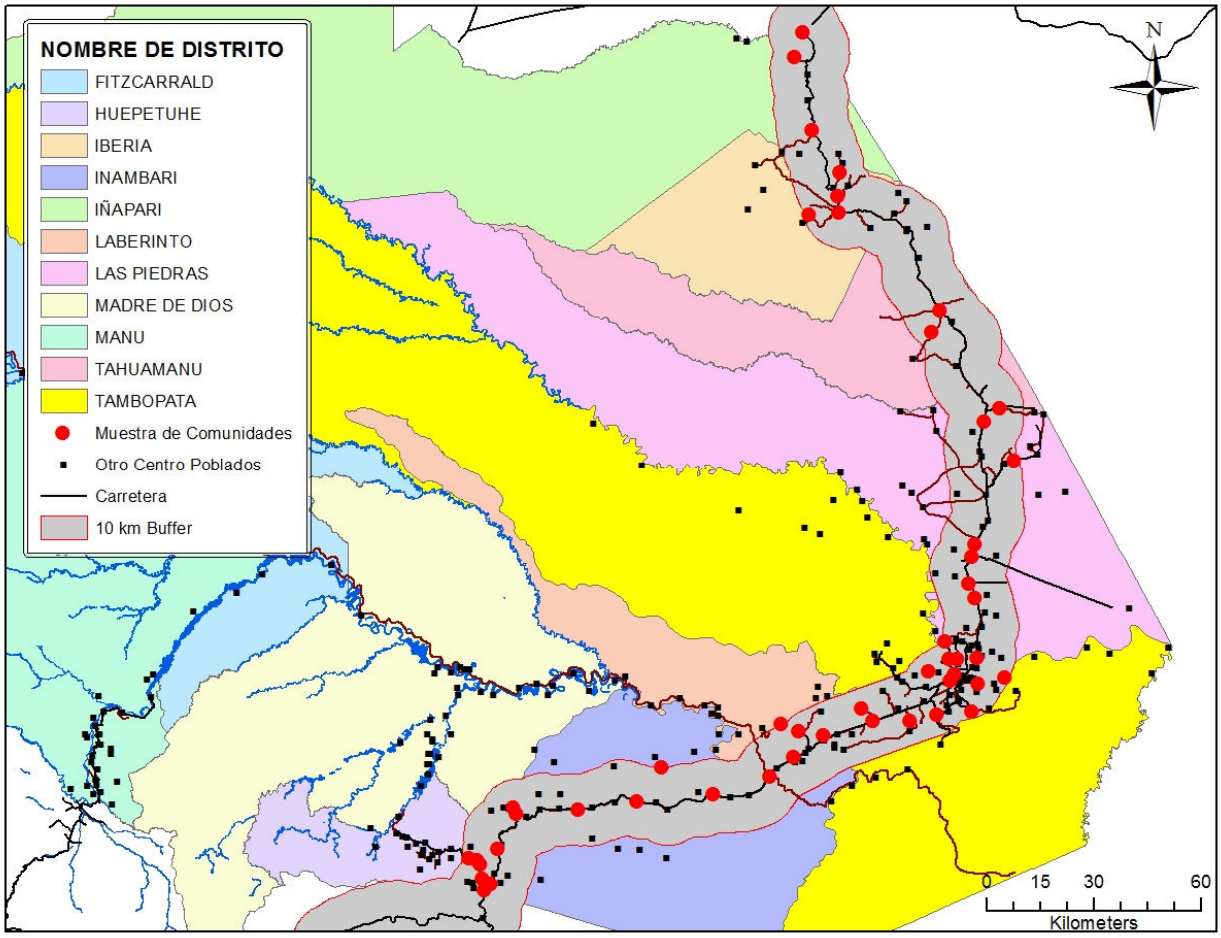

Figure 1. Map of the Madre de Dios, selected communities and the 10km study region buffer

Study Design

This is a cross-sectional observational study in which participants are randomly selected using a 2-stage PPS selection of communities and households. The stage 1 sampling frame consists of a listing of all communities in MDD, stratified by Urban/Rural status, excluding communities that are located further than 10km from the highway. This list was obtained from the National Census Bureau (INEI). Figure 1 shows the distribution of communities selected within the 10km buffer. Over 95% of the population of MDD lives in our 10km buffer. Households will be selected using a list sample when available, or every N^{th} home (after a randomly selected start household and until the total sample for that community is selected). Since this is a pilot study, only one round of data collection is planned.

Data collection

Two interviewers per household conduct the data collection. Interviewers will obtain data from the female and male heads of household. If only one head is available or if there is no spousal head, the interviewers will go over these items with the one head identified. If agreeable, the survey and biometric data will be obtained from all household members.

Study participants consist of all members of households that are selected to participate in the study. Household members are defined as those persons who normally sleep in the home or who have slept in the home the past 7 days. One household registration survey will be administered that includes one section on reproductive health to be given only to women of child-bearing age. The survey includes demographic characteristics of the household, economic activities, permanent and labor migration, household mobility in the past 3 months, land use, and health status. We will also obtain the following biometric data from all household members (unless otherwise specified):

- A thick and thin blood smear to test for malaria, which consists of a finger prick and drop of blood on a slide. The thick smear is used to detect presence of malaria parasites and the thin smear allows for identification of the species of malaria.
- 4 drops of blood onto filter paper for Dengue IgG antigen detection [58] and for malaria parasitemia quantification
- 10 μl of blood to measure hemoglobin using a Hemocue Hb201+. Anemia results will be reported immediately
- Anthropometric measurements include height, weight, and hip and waist circumference. In adults 18 and over we collect bioimpedence data, including percent body fat, percent muscle, and visceral fat.
- Blood pressure for all adults 18 and over

In addition to household survey data, we will conduct a facilities survey in communities selected as well as annual counts of malaria, dengue, leishmaniasis, and tuberculosis (from the health post if present). The community survey will consist of obtaining a listing of infrastructure, services and prices for common items. Listing of the available infrastructure and services will be conducted with key informants, including the community leaders (Alclade, *Presidente* or mayor), health workers, household heads, and store owners.

GPS locations will be recorded for all households surveyed and community facilities.

Analysis

As noted earlier, data collection is ongoing and data entry is being conducted simultaneously. *Data will be available for analysis in November 2011.* Analyses will focus on describing demographic, health and environmental outcomes and interrelationships. We will apply indirect demographic methods [57] to estimate fertility and mortality; analyze migration to determine differentials by age, gender, destination (urban vs. rural), duration (temporary vs. permanent) and places of origin, and participation in the local economy in regard to household structure. Health outcomes will include nutritional indicators in children under-5 (HAZ, WAZ, WHZ), anemia, malaria, 3-week morbidity recall, past and current dengue infection, obesity, fat and lean mass, systolic and diastolic blood pressure, and BMI. We will also examine activities by the household to protect health (e.g., vaccination, bednet use, limiting exposure to vectors, etc.). Environmental outcomes will include land use, operation of fish ponds, agroforestry and biodiversity conservation.