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Influencing rural livelihood switching through equipment assets for agroecosystems to alleviate pressure on resources

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ABSTRACT

Equipment provision influences livelihood choice by rural communities since it conditions their capacity to produce goods even with limited labor resources. This study examines how variations in equipment levels for fishing, rice cultivation, and copra farming affect the conditional probabilities of households in a rural Philippine community to adopt different livelihood strategies, particularly, to veer away from fishing and to adopt farming. A household survey profiled diverse income sources alongside available agricultural or fishing equipment. To determine a household's equipment index and rank its sophistication, the medoid clustering algorithm from data mining was used. Diverse farming equipment was classified into groups according to technology and ownership. Medoid clustering generated five different livelihood profiles comprising agricultural and non-agricultural work. An ensemble of decision trees created from nonparametric random forest regression predicted the conditional probabilities of a household's livelihood choice depending on equipment levels. Results revealed heterogeneity between the effects of rice and copra equipment – with rice exerting a stronger influence over households to choose farming over fishing. Rice is a potentially greater income earner and typically represents a primary form of livelihood. However, a threshold level of available equipment must be exceeded before households are strongly encouraged to choose rice farming, representing the minimum amount of capital needed to generate sufficient annual income and become a primary form of sustenance. Ultimately, the ideal configuration that will influence households to focus on agriculture is a combination of adequate levels of both rice and copra equipment, since both crops are complementary, addressing the need for agricultural diversification to mitigate various kinds of risk. A greater focus on agriculture would help address chronic food shortages, as well as hopefully alleviate fisheries overexploitation. For this strategy to be effective, however, issues of land ownership, access to irrigation and land degradation must also be addressed.

1. Introduction

The number and types of equipment assets available to households affect their capacity to produce goods. In economics, equipment is normally classified as "capital" which serves to augment the conditional productivity of labor, resulting in greater productivity with less time required. This ability of equipment to directly affect a household's income indicates an influence over the decision processes regarding choice of livelihood. Equipment can either reinforce or negate the effects of personal preferences. "Asset-strategies," which include work equipment assets, are considered to be among the determinants for the livelihood diversification of rural households (Ellis, 2000).

An empirical investigation was conducted of the actual conditional dependency of household livelihood strategies on varying configurations of equipment provision. In terms of practical application, information gained may be used to encourage the tendencies of households to switch among livelihoods in order to minimize environmental destruction or resource depletion – in this particular instance, to alleviate pressure on fisheries resources. Encouragement of switching also gives households the ability to diversify, conferring a certain resilience in the face of uncertainty, whether in the form of natural disasters or economic fluctuations (Cinner and Bodin, 2010).

Reflecting the situation worldwide, coral reef fisheries in the Philippines are over-exploited (Municipal Government of Abra de Ilog (MGADI), 2008; Worm et al., 2009; Muallil et al., 2014; MacNeil et al., 2015). A widely advocated prescription is the establishment of marine protected areas (MPAs; Green et al., 2014). Fishing is to be minimized or even prohibited within designated MPAs, depriving fishers of a

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livelihood source they have depended on for generations or even centuries (Muallil et al., 2014).

A more realistic strategy would entail − together with MPAs − alternative forms of livelihood for the affected communities, as, indeed, has been recognized in many instances (Worm et al., 2009; Reddy et al., 2014). This approach assumes that alternatives do exist by which erstwhile fishing communities may earn an income at least comparable to, or even better than, that derived from fishing.

Perhaps the most readily available livelihood alternative to fishing in typical rural areas is terrestrial agriculture. At present, the two most prevalent agricultural activities in the study area, being a coastal barangay (Municipal Government of Abra de Ilog (MGADI), 2008; described below), are rice and copra farming. Corn is an important crop in the more inland locations.

Rice is considered the staple food and principal crop in the Philippines, as in many tropical countries, and constitutes the major source of calorie intake (Villano and Euan, 2006). Rice farming is likewise the single most important source of rural employment and income (Villano and Euan, 2006), meriting its being the focus of several studies in development economics (Bravo-Ureta and Pinheiro, 1993; Battese and Coelli, 1995).

Interestingly, switching towards an agriculture-based livelihood strategy would not only potentially prevent over-exploitation of fishery resources, but could also enhance economic well-being (Bravo-Ureta and Pinheiro, 1997). Bravo-Ureta and Pinheiro (1997) state that there is "considerable agreement" among development economists that effective development strategies entail promotion of agricultural productivity among small-scale producers (such as peasant farmers) since it provides employment in the rural sector and a more equitable distribution of income. To promote productivity, several examples from classical economic literature (Schultz, 1964; Kuznets and Murphy, 1966) suggest the adoption of better technologies (of which equipment largely forms a part). In addition, chronic rice shortages occur in the Philippines (Timmer, 2010), partly blamed on "technical inefficiency" (Villano and Euan, 2006) − for which shortage of equipment among the rural small-scale peasantry is a probable cause.

It would be logical to engage fishers, who are already exploiting a dwindling resource base, to move towards agriculture to augment food supply. An important incentive could be the provision of technological equipment. It is, of course, recognized that rice farming takes its own toll on the environment, as forested or other pristine habitats are cleared to make way for production. Deforestation results in increased sedimentation which can impact coastal habitats (Maina et al., 2014). Sustainable rice cultivation (e.g., Pittelkow et al., 2015) is not the subject of this paper, however.

The focus of this study is a Philippine rural community on the biodiversity-rich island of Mindoro (Brown and Diesmos, 2009), spanning habitats that include high mountains, forests, rivers, agricultural areas (mainly rice and coconut) and coral reefs. It is explicitly recognized that the different habitats, whether terrestrial, freshwater or marine − actually constitute one ecosystem − as they are interconnected both physically (in terms of material and energy flows) as well as in terms of human exploitation, i.e., humans switch from one livelihood to another for economic expediency. The coral reefs are severely overfished as indicated by the conspicuous absence of marine large predators (Bedard, 2015).

Rice farming remains the most important economic sector in Mindoro though the crop is in chronic short supply mainly due to impacts of extreme weather (Pullen et al., 2015). Another potentially important income earner is copra from coconut (Municipal Government of Abra de Ilog (MGADI), 2008).

To examine which equipment asset configurations can encourage rural households to choose farming-intensive livelihood types over fishing, the data-driven computational approach used is divided into two (2) parts. The first part involves the use of a data mining tool called medoid clustering to construct equipment asset indices that classify the level of equipment available to a household. Likewise, medoid clustering determines the distinct livelihood profile types. The second part uses random forest regression to assess the impact (seen via predicted conditional probabilities) of varying equipment indices on the choice of livelihood profile.

2. Material and methods

2.1. Subject rural area

Barangay Udalo is within Abra de Ilog, a second class municipality of the province of Occidental Mindoro, the Philippines (Municipal Government of Abra de Ilog (MGADI), 2008), located on the northwestern side of Mindoro island facing the Verde Island Passage. According to the latest available census (National Statistics Office, 2010), the municipality had a population of approximately 30,000 distributed among nine (9) barangays, only one of which, barangay Poblacion, is urban. Three (3) barangays, namely, Wawa, Udalo (Camurong) and Lumang Bayan, are coastal with a relatively high population density.

Agriculture remains the primary source of employment, engaging 46% of the total labor force (2008 Comprehensive Land Use Plan, Municipal Government of Abra de Ilog (MGADI), 2008). This number includes farming as well as inland aquaculture and marine fisheries. Around 17,738 ha, out of the total land area of 72,453 ha, are allocated for agriculture. Roughly 10,000 ha are classified for pasture, 4532 for different kinds of crops, and 3206 for expansion of agricultural activities. A sizeable percentage of croplands (2480 ha or 14%) is used for rice production, followed by corn (816 ha or 5%), and vegetables, root crops and legumes (149 ha or 1%). There are areas planted to permanent crops like coconut (630 ha or 3.6%). Fishing, both marine and inland, represents only a fraction of individuals employed under the agriculture sector (Municipal Government of Abra de Ilog (MGADI), 2008).

The tertiary sector includes commerce (wholesale and retail trade) and tourism. Wholesale trade in the municipality encompasses buyers and sellers of grain, copra, soft drinks and scrap metal. For retail, a large number are "sari-sari" (small retail involving a variety of consumer goods) store owners. Other examples of retailers are meat vendors, bakeries, drug stores, vegetable dealers, and general construction.

2.2. Survey

The largest coastal barangay, Udalo (ca. 13°26′13.97"N; 120°50′37.62"E), is considered fairly representative of the general population but with a greater dependence on fishing. It occupies a total land area of 10,725 ha with a human population of about 3700 as of the latest census. Twelve (12) independent villages, separated by distances of 1–12 km, were covered in the survey, occupying a range of habitats from mountain, riverine, agricultural land, all the way to the coast. Data gathering encompassed the period 2013–2015. Households were sampled randomly within each village, following a statistically significant sample size with 90% confidence levels that was determined using the following formula:

$$n = \frac{NZ^2(p)(1-p)}{Nd^2 + Z^2(p)(1-p)}$$

where:

n = sample size

N = Population

Z = Z value of 1.96 for 95% confidence level

P = percentage picking a choice expressed as decimal (i.e., 0.5 for sample size needed)

D = confidence interval expressed as a decimal (i.e., 0.05 for ± 5% margin of error)

Altogether, 268 households were covered. Their ethnicity could