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Exogenous degradation in the commons: Field experimental evidence

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ABSTRACT

This article presents the results from framed field economic experiments in rural Colombia that aim to explore the behavioral responses of resource users to exogenous changes in the availability of a common-pool resource. In the first 10 rounds of the experiment, all subjects played at a baseline with the same initial resource availability. In the subsequent rounds, the experimenters exogenously changed the resource size, including mild and strong reductions in the resource size and rebounds to original size. Results show that subjects react to strong reductions in resource availability, by increasing appropriation from the resource. This behavior holds for intense and persistent as well as for progressive reductions in resource availability. In addition, subjects that experience a reduction in the resource availability followed by a rebound to the initial resource size appropriate more than those subjects who did not experience any change in the resource availability.

1. Introduction

Degradation of natural resources is nowadays perceived as a common threat in the scientific community (Millennium Ecosystem Assessment, 2005; IPCC, 2013, 2014). Some examples of drivers of degradation of ecosystems are users' resource appropriation (e.g. drainage of river flows through irrigation, depletion through overuse), fragmentation of ecosystems associated with land conversion (e.g. deforestation for agricultural expansion or livestock), pollution (e.g. oil spills), or short and medium term ecological shocks (such as droughts or floods). The literature on conservation of common pool resources (CPRs) has extensively focused on the degradation associated with overuse and expanding land use. Considerable field evidence (Agrawal, 2001; Baland and Platteau, 1996; Ostrom, 1990, 2009; Wade, 1988) and experimental evidence (Ostrom et al., 1992, 1994) have been instrumental in understanding under what institutional arrangements CPR users can increase cooperation levels. Other streams of the literature (Brondizio et al., 2009; Moran, 2009) have focused on the different drivers that lead to changes in land use. However, previous research has not addressed as much the conservation challenges associated with exogenous variation in ecological variables and biophysical conditions (see discussion in Anderies et al., 2011). In this paper we focus on how people react to exogenous changes in the availability of a shared resource in the controlled environment of a framed field economic experiment.[2]

Exogenous variations in the availability of natural resources can result from environmental disasters such as droughts, floods or other

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[2] According to the taxonomy by Harrison and List (2004), the type of experiment that we conducted in this study is a framed field economic experiment as opposed to a conventional laboratory experiment. In the latter, the population involved in the study was composed of students (convenient sample for academics). Additionally the experiments are framed neutrally, meaning that the decision making context is abstract. These experiments have been criticized for including only "Western, educated, industrialized, rich and democratic" (WEIRD) (see Henrich et al., 2010). By conducting frame field experiments, the researcher expands not only the demographic characteristics of the sample but also the heterogeneity in social preferences such as values and norms (Bouma et al., 2014). Additionally, the task the participants are asked to do is familiar to their day-to-day activities.

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disruptions of natural processes. While those variations are independent from past appropriation decisions by users, they can have significant impacts on the user's future decisions. Previous experimental research conducted in Africa shows that soil fertility and water availability affect risk aversion, loss aversion, discount rates and anti-social behavior (Di Falco, 2014; Prediger et al., 2014; Tanaka and Munro, 2013). Tanaka and Munro (2013) show that farmers in the least favorable climatic zone in Uganda are the most risk averse, loss-averse and impatient. Similarly, Di Falco (2014) shows that more rainfall variability is associated with higher risk aversion in Ethiopia. These results are relevant insofar as these suggest that increased variability in the availability of resources may lower the propensity of farmers to undertake investments in physical and human capital, which in turn compromises economic development (Tanaka and Munro, 2013). Prediger et al. (2014) present additional results showing that in Namibian villages where soil fertility is more limited due to geological characteristics, farmers display significantly higher levels of anti-social behavior. The authors attribute this result to increased competitive pressures among users of natural resources when these resources are scarcer. Similarly, Hendrix and Salehyan (2012) and Hidalgo et al. (2010) find a significant effect of rainfall conditions on the occupation of large landholdings by the poor, and increased propensity of disruptive activities such as demonstrations, riots, strikes, communal conflict and anti-government violence. Understanding the responses of users to such exogenous changes is increasingly important given the predictions for climate change scenarios on the risks of extreme events and disasters (IPCC, 2013, 2014).[3] This is particularly true when considering that the behavioral implications of climate change might influence the adaptation strategies that the affected subjects might pursue (Di Falco, 2014). Therefore, the design of future programs and policies for conservation of natural resources might need to take into consideration not only the given environmental conditions in a location, and the historical use of resources, but also the expected regional and local implications from climate change and the associated potential behavioral changes of resource users due to the changes in the availability of resources.

This article aims to advance the study of responses of natural resource users to environmental change. In particular we address how exogenous changes in the availability of a shared resource affect the appropriation decisions of its users. For this purpose we conducted a framed field experiment with peasants in rural Colombia. In particular, we aim to test specific conjectures on (a) the *magnitude* effects of mild and strong reductions in resource size, and (b) the *order* effects of intense vs. progressive decreases in the size of the resource and of rebounds in the resource size after a mild decrease.

The region of Latin America and the Caribbean is extremely vulnerable to climate change due to its topographical and geographical characteristics; within the region, the Andean and the intertropical regions face the biggest problems (Samaniego, 2009).[4] According to climate change predictions for Latin America, an increasing amount of areas in the region is expected to face droughts in the future, with consequence for different sectors (agriculture and silviculture, hydrological resources, human health and industry and settlements) (IPCC, 2007). In particular, water availability, decreased food production and food quality are key risks associated with climate change that are strengthened by the fact that poverty is a critical determinant to vulnerability to climate change (IPCC, 2014). As the IPCC (2014) highlights, despite the substantial economic growth observed in Central and South America for the last decade, there is still a high level of heterogeneity in socioeconomic development and very unequal income distribution, resulting in high vulnerability to climatic conditions. For Colombia, forecasts show an average temperature increase of 2% and an increase in the volatility of precipitations, with some regions facing decreased rainfall and others encountering increasing rains (Garcia et al., 2012). Our experiments were conducted in the Coello watershed in the central Andean Cordillera, one of Colombia's most important watersheds. The watershed hosts an intense agricultural activity (including a notable share of the national rice production), and also serves various important city and village aqueducts. The Coello watershed has not experienced water quantity restrictions in the past, but there is growing concern about climate change and future rainfall decreases in the area.[5]

This study complements the scholarship emerging from framed field experiments in Latin America. While much of this scholarship addresses the impact of different institutional arrangements (Cardenas, 2011; Cardenas et al., 2000; Janssen et al., 2012; Velez and Lopez, 2013; Velez et al., 2010) our study focuses on the effect of changes in biophysical conditions, namely the size of a shared resource. The few previous field studies addressing changes in resource size have focused on testing the role of endogenous scarcity (resulting from resource use dynamics) on appropriation behavior (Janssen et al., 2013; Moreno-Sanchez and Maldonado, 2010; Prediger et al., 2011; Vollan et al., 2013). Our study complements these works by addressing exogenous variations in the availability of shared resources in a static game. The sort of climate-change impacts on the availability of local natural resources that we aim to capture in the experimental design are unrelated to appropriation decisions of local commons, and therefore exogenous to users. Thus, despite the relevance of endogenous degradation of resources, we abstract from dynamics in the game and impose exogenous changes (i.e. not associated with previous appropriation decisions) in the size of the shared resource. In addition, this study contributes to related experimental studies with university students adopting a between-subjects design. These studies implement variations in resource availability whereby each subject faces only one resource size during the experiment while different groups face different resource sizes (Osés-Eraso and Viladrich-Grau, 2007; Osés-Eraso et al., 2008; Rutte et al., 1987). In our study, the sort of climate-change induced events that we aim to capture in the experimental design imply that subjects *experience* variations in the resource availability during their life span. Thus, we believe that it is critical to induce changes during the game in the size of the resource from which subjects can appropriate, and therefore we use a *within subjects* design.[6] Our study addresses a similar question to that uncovered by Cinner et al. (2011). The authors assess the responses of Tanzanian fishermen to four hypothetical scenarios of increasingly severe declines in their average catch. Contrary to that study, we incentivize subject's decisions by linking cash payments to decisions during the game and at the same time we incorporate a broader set of treatments in our experimental design.

2. Study Area

The Coello watershed covers an area of 190,000 ha with annual rainfall ranging from just below 1000 mm to more than 3970 mm (Johnson et al., 2009). The watershed ranges from 280 to 5300 m above sea level, with a wide variety of ecosystems (e.g. dry tropical forest, high Andean forest and paramos). According to national statistics the watershed has approximately 670,000 dwellers (DANE, 2005). The most important economic activities in the watershed are agriculture and livestock, and

[3] See also the special issue of *Science*, August 2, 2013, on "Natural Systems in Changing Climates" for a general discussion of the current state of knowledge about the effects of climate change on natural systems.

[4] In fact, for the whole region, from 2000 to 2005 the amount of droughts, floods and landslides has increased 2.4 times with respect to the years 1970–1999.

[5] This concern is shared by the users as well as NGOs operating in the area such as WWF Colombia and Semillas de Agua, with which we collaborated to carry out the experiments.

[6] As noted by List et al. (2011) a within-subjects design may bring advantages and disadvantages. The advantages include that this design minimizes the fact that a treatment is correlated with individual characteristics, and increases the precision of the estimated average treatment effects. Among the disadvantages the authors noted that the variance of the outcomes is potentially very large, and that by having the same person playing different conditions, it may allow the subject to include history and learning effects into his decision making process. Our design addresses the relevance of the history of play along the game as part of our conjectures.