



Management and time preferences for lakes restoration in Brazil

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HIGHLIGHTS

- Household preferences for the restoration of five lakes in Brazil are investigated.
- A mixed logit model was estimated in willingness-to-pay space.
- Willingness to pay decays with restoration time in a non-linear fashion.
- Non-governmental management is preferred over the municipal government.

GRAPHICAL ABSTRACT



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ABSTRACT

As in many developing countries, the eutrophication of lakes has become one of the most severe environmental problems in Brazil. We implemented a choice experiment to investigate local preferences for the restoration of five lakes in the city of Campos dos Goytacazes, Brazil. This study focuses on two attributes of the proposed environmental project: 1) the delay in reaching the targeted level of water quality and 2) the institution that would manage the lakes restoration project. Choice responses are analyzed using a mixed logit model to control for potential heterogeneity among respondents. Results show that the willingness to pay for lakes restoration decays with restoration time in a non-linear fashion. Findings also indicate that respondents would prefer an interinstitutional, non-governmental committee over the municipal government to manage the lakes restoration project.

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1. Introduction

Hydrological ecosystems such as rivers and lakes have the potential to contribute to the development of communities in developing nations due to the multiple services they can provide (e.g. drinking water,

irrigation, fishing, and recreation). Unfortunately, many rivers and lakes have suffered from anthropogenic eutrophication to the extent that some of them currently represent a considerable risk for the health of surrounding populations (Tundisi and Scheuenstuhl, 2014). Brazil is an example of how economic and urban development has taken a toll on the quantity and quality of water bodies (Costa, 2003; Pedrosa et al., 2004; Rezende et al., 2006). Hence, improvements of water quality would help mitigate health risks and restore services lost due to lakes eutrophication (Keeler et al., 2012).

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Restoring lakes is costly and developing nations may lack the resources required for lakes restoration as they face other pressing needs that compete for budget priority (e.g. poverty alleviation programs, education, health care, drinking water, and sanitation, among others). The lack of information on the economic value of water quality improvements has been an impediment for making budget allocations to lake restoration projects (Keeler et al., 2015). Economic valuation of lake restoration projects has the potential to contribute to the determination of priorities by demonstrating the relative importance of lakes to surrounding populations. For instance, using the contingent valuation method, Wang et al. (2013) demonstrated that households are willing to pay approximately 3% of their monthly income for five years in order to restore the water quality of Lake Puzhehei in China. Similarly, Van Houtven et al. (2014) reported significant willingness to pay for water quality improvements in the United States (an annual average of \$60 per household in the state of Virginia).

We implemented a discrete choice experiment (DCE) to investigate the benefits of restoring the water quality of five urban lakes in Campos dos Goytacazes, Brazil. This study focuses on two attributes of the proposed environmental project: 1) the delay in reaching the targeted level of water quality and 2) the institution that would manage the lakes restoration project. Recent studies have implemented DCEs to investigate time preferences for water quality improvements given that environmental projects tend to deliver expected outcomes with some delay (Kahn et al., 2017; Meyer, 2013; Viscusi et al., 2008). Those studies consistently show that households are somewhat impatient in observing environmental improvements. Most of those studies (e.g. Meyer, 2013; Viscusi et al., 2008), however, have investigated time preferences using optimistic levels of delay in observing targeted water quality improvements (e.g. five years or less). Other studies have proposed delays that will likely outlive the average respondent. For example, Kahn et al. (2017) considered up to 60 years of delay in restoring the water quality of the Paraíba do Sul river in Brazil. We consulted local scientists to determine more realistic restoration times for the lakes in question (10 to 20 years).

Additionally, our experimental design includes two potential project managers: 1) the municipal government and 2) an interinstitutional non-governmental committee. It has been shown that households' willingness to pay for improved water services may vary depending on the service management approach. For example, using the contingent valuation method, Vásquez and Franceschi (2013) estimated the willingness to pay for improved water services in León, Nicaragua. Their findings indicated that households were willing to pay a premium if the improved service was managed by the current national water company rather than decentralizing it at the municipal level. A majority of respondents considered the national company to be more accountable as well as technically and financially capable compared to the municipal government. In a related contingent valuation study conducted in a small town of Guatemala, Vásquez (2014) found that households with municipal services were willing to pay for water service improvements while households with community-managed services were not. Similarly, based on a hedonic pricing study implemented at the national level in urban Guatemala, Vásquez (2013) found that households valued having access to water services only if those services are provided by municipal governments rather than by private utilities and community-managed systems. Given that municipal, private, and community-managed systems were comparable in terms of service reliability, Vásquez (2013, 2014) argued that value differentials are due to institutional characteristics of water utilities. As a result of weak regulation, private utilities have the highest tariffs while providing similar services. In the case of community-managed systems, water users are required to undertake managerial duties which counteract the benefits of having access to water.

The analysis of household preferences regarding the management of environmental projects is particularly important in Brazil given a

widespread perception of corruption at all government levels.¹ Households may adjust their preferences to project their rejection of the municipal government as a potential manager of the proposed lakes restoration project. Under these circumstances, alternative management approaches may be required to earn public support. This study analyzes household preferences for an interinstitutional, non-governmental committee as an alternative to the municipal government for managing the lake restoration project.

We analyze choice responses using a mixed logit model to account for potential heterogeneity among respondents. It is customary to estimate choice models in preference space and then transform the estimated coefficients to monetary values. However, that approach may result in unconventional, heavily skewed distributions for willingness-to-pay estimates (Scarpa et al., 2008). Alternatively, one can estimate the mixed logit model in willingness-to-pay space, which allows for making distributional assumptions directly on the monetary values and provides willingness-to-pay estimates that are presumably more precise (Train and Weeks, 2005; Hole and Kolstad, 2012). For those reasons, an increasing number of recent studies have estimated choice models in willingness to pay space (e.g. Balogh et al., 2016; Durán-Medraño et al., 2017; Kahn et al., 2017; Martínez-Jauregui et al., 2016). We follow this approach to investigate local preferences for different attributes of a lakes restoration project. Estimation results indicate that respondents' willingness to pay for lakes restoration decreases with restoration time in a non-linear fashion. Our findings also suggest that there is minimal support for the local government to undertake the proposed project, mainly because it is perceived as corrupt and incapable of containing project costs.

The rest of this paper is organized in the following sections. Section 2 provides a general overview of the study site and the water quality of its lakes. Section 3 presents the survey methodology and the DCE design. Section 4 introduces the analytical framework and econometric methodologies used to analyze respondents' choices. Section 5 shows the survey and estimation results. Section 6 concludes the paper with a discussion of our findings and their policy implications.

2. The city of Campos Dos Goytacazes and its lakes

Located approximately 275 km northeast the city of Rio de Janeiro, Campos dos Goytacazes (hereafter refer to as Campos) is the largest municipality of the Rio de Janeiro state with an area of 4026 km². According to the last demographic census, Campos had a population of 463,731 inhabitants as of 2010; most of which (90.3%) lived in the urban center. The average household had approximately three members with monthly income of R\$ 2251. The average monthly income was R\$ 2372 in urban areas and R\$ 1105 in rural areas.²

The city of Campos has several lakes including Cima (14.8 km²), Campelo (10.2 km²), Das Pedras (1.48 km²), Taquaraçu (0.51 km²) and Vigário (0.25 km²), all of which are relatively shallow (<2 m). The more extensive lakes, Cima and Campelo, are located outside the city surrounded by pasture and sugar cane (see Fig. 1). Lakes Das Pedras, Taquaraçu and Vigário are located within or closer to the city, exposed to sewage and garbage disposal. Recent analyses revealed the presence of fecal coliforms in those lakes (above 2400 CFU/100 mL), making it unsafe for humans to have direct contact with their waters. Also, Jesus et al. (2012) found that Mercury levels in carnivorous fishes from Lake Campelo are above Brazilian legal standards for human consumption (500 ng·g⁻¹ in wet weight). Based on those results, local scientists have classified the five lakes as Type IV which, according to Brazilian

¹ According to the public opinion polls of Transparency International, a vast majority of Brazilians believe that both political parties (81%) and the legislature (72%) are very corrupt. In contrast, many Brazilians (65%) perceived non-governmental organizations as honest (see <http://www.transparency.org/gcb2013/country/?country=brazil>, last accessed on December 21, 2017).

² The census information was retrieved from <https://cidades.ibge.gov.br>, last accessed on November 14, 2017.

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