Conservation and development: Socioeconomic Impact evaluation of Terrestrial Protected Areas in Madagascar based on large national surveys

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Abstract

Protected Areas are the most widely used tool for biodiversity conservation. However, their implementation raises concerns about the well-being of local populations, especially when they are very poor and dependent on natural resources, as is the case in Madagascar. This pre-analysis plan outlines the data, methods, and empirical strategies used to evaluate the impact of protected areas on local household well-being and the inequalities among them. Our study focuses on terrestrial protected areas and relies on Demographic Health Surveys spanning a 13-years period (2008-2021). We will also use data from the previous 11 years (1997-2008) to assess whether parallel trends prior to the study period confirm the validity of the comparisons. The data will be analyzed using spatio-temporal models, matching, and difference-in-differences methods.

Keywords : Biodiversity Conservation, Well-Being, Demographic and Health Surveys, Spatio-Temporal Models, Geospatial impact evaluation, Madagascar

JEL codes : Q57, I31, C31, Q56, O55

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Proposed timeline

Phases	Dates
Literature Review, Conceptualization, and writing of the Registered report	May 2024 - January 2025
Retrieve data from selected sources	February 2025
Data cleaning and analysis	February - March 2025
Writing the scientific article	March 2025 - April 2025
Submission to the journal	April 2025

1 Introduction

The reconciliation between conservation and development has been a long-discussed issue within the scientific community (Adams et al., 2004) , but its importance has grown considerably over the past decade with the rapid expansion of protected areas (PAs). This issue is particularly relevant for all 195 COP15 signatory states, which have committed to increasing protected areas coverage to 30% of terrestrial land by 2030.

In theory, protected areas can have significant impacts on local livelihoods, both positive and negative. They are recognized as an essential tool for biodiversity conservation (Maxwell et al., 2020), but their creation can deprive nearby communities of access to natural resources (gathering, hunting, fishing, and medicinal plants), reduce the amount of land available and restrict economic activities (agriculture, livestock, construction) (Kandel et al., 2022). Conversely, they can be accompanied by compensation measures (local development projects, cash transfers), generate economic benefits (jobs in protected areas, tourism), and enhance ecosystem services (increased water resources, erosion control, fire prevention) (Kandel et al., 2022).

Despite these ambivalent potential effects, empirical studies that rigorously assess the impact of protected areas on people's livelihoods are still rare. Of the 1,043 studies reviewed by McKinnon et al. (2016) , only 19 used quantitative methods to evaluate impacts on material living conditions or economic well-being. This meta-analysis shows that the results of studies vary widely depending on the methods used, the context studied, and the location. Kandel et al. (2022) have updated and extended this analysis by focusing on a corpus of 30 quantitative evaluations that specifically address the impact of protected areas on household income. They show that protected areas can have a positive impact on local economies, but that this effect is generally modest and depends on the local context. This variability in impacts highlights the importance of conducting context-specific studies using robust quantitative methods.

Madagascar stands out as a particularly relevant case study for analyzing the relationship between conservation and socioeconomic conditions. The country is the poorest in terms of the first target of the Sustainable Development Goals (SDG 1-1), with the highest proportion of the population living below the international poverty line in the world (Conceição (2024), p. 298-99). In 2008, terrestrial protected areas covered 3.6% of Madagascar and 9% of the population lived within 10 km of a protected area. Today, they cover 10.8% and 28% of the population live within 10 km of protected areas[8]. Madagascar is also characterized by a low state capacity (Hanson & Sigman, 2021), which makes it difficult to implement conservation and sustainable development policies and the social measures that should accompany them. These factors, combined with the high dependence of the rural population on natural resources, mean that the impacts of protected areas are potentially different from those observed in less precarious contexts.

However, empirical studies at the national scale are almost non-existent for Madagascar. None of the quantitative impact evaluations identified by McKinnon et al. (2016) covered the country. One of the references consolidated by Kandel et al. (2022) is a multi-country study that includes Madagascar, but it is based on an estimate of an aggregate impact at the commune level and covers only one

date. It uses the 1993 census data to match the country's municipalities (Mammides, 2020), without a before-and-after comparison, and in a context where less than 3 % of the territory was covered by protected areas, most of which had been created several decades earlier.

Our contribution to the literature is twofold, both empirical and methodological. Empirically, this study provides an unprecedented national analysis, covering 71 protected areas established between 2008 and 2021, to evaluate the socioeconomic impacts of conservation in contexts of extreme poverty and weak governance. Methodologically, it articulates the state of the art in econometrics, incorporating recent developments to adapt these methods to the study of protected areas. The procedure we propose here could be replicated in other countries, starting with the 39 countries that have at least three geolocated DHS surveys. This approach paves the way for a more systematic evaluation of the impact of protected areas, taking into account the specific context of each country.y.

2 Research Design

2.1 Hypothesis

Our first hypothesis concerns the overall impact of protected areas in the Malagasy context. In their meta-analysis of 30 studies, Kandel et al. (2022) report a slightly positive average impact, but highlight a large heterogeneity of results across context. Several parameters are likely to influence impact, as represented graphically in Figure 1 in the form of directed acyclic graph (Hünermund & Bareinboim, 2023; Imbens, 2024)

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[8]Calculations by the authors based on the location of the DHS survey clusters. The detailed calculation is provided as supplementary material to the study.
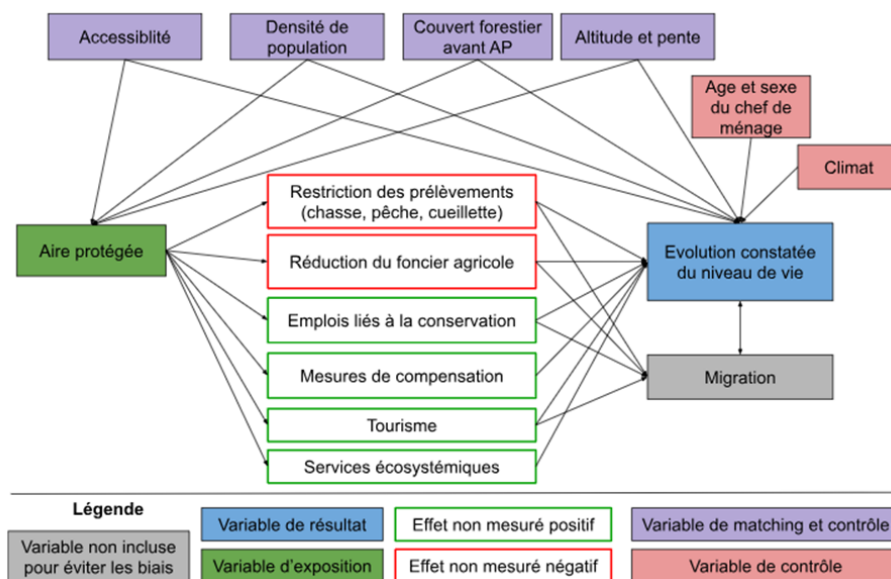
Figure 1: Logic diagram of the theory of change tested in the study

Source:Authors

The factors likely to lead to a decline in well-being seem particularly significant in the Malagasy context, where the population is predominantly rural and living in extreme poverty (the last assessment was in 2012, with 80.7% of the population below the $2.15 a day threshold at 2017 PPP). Six studies conducted in Madagascar between 1995 and 2006 estimated the opportunity cost of losing access to protected areas (slash-and-burn agriculture, hunting, gathering, timber, etc.) at between USD 39 and 177 per household per year (Neudert et al., 2017). Golden et al. (2014) estimated that income from hunting accounted for 57 % of household cash income in areas adjacent to the Makira and Masoala protected areas. Another survey of people living near Makira estimated the value of pharmaceutical use at USD 30-44 per year per household, based on the subsidized price of equivalent treatments in the malagasy market (Golden et al., 2012).

Several factors that could help improve livelihoods through conservation appear to be fragile in Madagascar, starting with tourism. Naidoo et al. (2019) aggregate data from DHS surveys conducted between 2001 and 2011 in 34 developing countries. Their study is based on matching households near and far from protected areas, but with no pre-post conservation comparison. They highlight positive impacts, but only for a subset of protected areas 'with documented tourism'[9]. According to their study, households living near the protected areas 'with tourism' are 17% wealthier and 16% less likely to be poor than similar households living far from these areas.

However, tourism in Madagascar's protected areas remains low. According to data from Madagascar National Parks (MNP), only 7 protected areas recorded more than 10,000 visitors in 2023 (with a maximum of 30,744 in Isalo), which is low compared to the average of 356,405 visitors per year and

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[9]The source used to consider that va PA has 'documented tourism' is not reported in Naidoo et al 2019.

per PA recorded in 929 PAs worldwide in the global study by Chung et al. (2018). When new protected areas are created in Madagascar, compensation mechanisms for local populations remain rare, ineffective and insufficient (Bertrand et al., 2012; Rivière, 2017). The most in-depth study on this subject, conducted by Poudyal et al. (2018) with support from the World Bank, focuses on the Ankeniheny Zahamena Corridor (CAZ), created in 2015 to connect several existing protected areas. Five study sites were selected: Two adjacent to the new CAZ protected areas (one eligible for compensation, the other not), two adjacent to long-established protected areas, and one far from the forest boundary. The median cost of the conservation restriction is estimated at USD 2,375 per household per year, representing 27% to 84% of the average annual income. The amounts set aside to compensate beneficiary households were assessed to be insufficient relative to the losses incurred, and 50% of households eligible for compensation received nothing (Poudyal et al., 2016, 2018).

- Hypothesis 1: Protected areas in Madagascar, by limiting access to natural resources, have negative impacts on the well-being of nearby households that often exceed the benefits of compensation and ecosystem services, with more adverse impacts than in other countries.

The impact mechanisms represented in Figure 1 are likely to affect households differently depending on their prior characteristics. Compensation measures are generally implemented in the form of projects to promote income-generating activities (agriculture, livestock, handicrafts) in surrounding communities (Poudyal et al., 2018). In the context of such development projects, individuals known as 'development brokers' frequently emerge as intermediaries between local communities and implementing organizations. By mobilizing their social networks and specific skills, these brokers manage to capture a disproportionate share of the benefits of interventions, whether in form of income or access to exclusive opportunities. This dynamic can reinforce pre-existing inequalities within communities, limiting the access of the most vulnerable households to the expected benefits of compensation programs.

Although tourism development is often presented as an opportunity for economic growth, it also tends to exacerbate socioeconomic inequalities, particularly in developing countries. Adeniyi et al. (2024) show that in Southern Africa, tourism can initially exacerbate inequalities by concentrating benefits in the most attractive regions, while leaving marginalized communities out of the economic benefits. According to Ghosh and Mitra (2021) the relationship between tourism and inequality follows an inverted Kuznets curve dynamic in developing countries, when tourism remains moderate, its growth reduces binequalities, but when tourism becomes massive, further expansion worsens inequalities. Finally, Xuanming et al. (2024) point out that while tourism helps to improve certain socioeconomic indicators, it can also generate inflationary pressures and strain local resources, particularly affecting the most vulnerable households.

Hypothesis 2: Protected areas exacerbate economic inequalities among neighboring communities by creating opportunities that mainly benefit individuals with a higher educational level or a dominant position in the community, allowing them access to rents and jobs related to tourism and associated activities.

Protected areas IUCN status is frequently used to explain differences in effectiveness between them.

For example, Naidoo et al. (2019) show that multiple-use protected areas (statuses V and VI) tend to have more beneficial effects than strict areas (statuses I to IV), partly due to greater flexibility in integrating local needs. Beyond status alone, governance plays a central role. Eklund et al. (2017) highlight the importance of transparent and inclusive structures to maximize the positive effects of protected areas on conservation and social justice. Similarly, Eklund et al. (2019) call for management approaches to be adapted to local contexts, with greater involvement of communities in decision-making processes, to better reconcile conservation and development objectives.

This diversity is particularly evident in Madagascar. Although governed by similar formal statutes, protected areas follow different paths depending on the local context and the way in which they are implemented. Froger and Méral (2009) show that the early initiatives of shared governance, gradually introduced with in-depth mediation efforts, achieved encouraging results by strengthening local community support. However, from the 2000s onward, the accelerated deployment of management transfers, driven by quantitative targets, often led to hasty and less contextually adapted implementations, undermining the effectiveness of these mechanisms. These experiences demonstrate that, beyond the protected area status, their establishment period, management approach, and level of community participation significantly influence their socio-economic impacts.

- Hypothesis 3: The impacts of protected areas on well-being and inequalities are heterogeneous, and some protected areas with good levels of local community participation manage to generate greater benefits and distribute them more equitably.

2.2 Basic methodological framework / identification strategy

Our evaluative approach is based on a counterfactual measure that estimates the causal effect of the treatment, in this case the presence of protected areas. The counterfactual measure corresponds to a hypothetical scenario describing what would have happened if the intervention under study had not taken place. This approach is based on a comparison between a treatment group (a protected areas) and a control group (unprotected areas with characteristics very similar to those of the protected areas). The study thus fits within the framework of Rubin's causal model Rubin (1974), according to which there are several hypothetical outcomes depending on exposure to the treatment. To ensure comparability between groups, matching techniques are used to assign each unit in the treatment group to a unit with the same observable characteristics in the control group. Using matching increases the credibility of research results and reduces endogeneity problems (Ma et al., 2020).

We subsequently use the difference-in-difference method to estimate the causal effect attributable to the creation of protected areas. This method allows us to compare the observed changes in the treatment group and control group, while compensating for pre-existing differences between these two groups. By comparing the differences in local households livelihood before and after the creation of the protected areas, we isolate the specific effect of the creation of these protected areas. Matching and difference-in-difference methods are often used together to reduce selection bias. Several studies have used this combination of methods to evaluate the impact of conservation on land use and livelihoods (Ma et al., 2020; Schleicher et al., 2020).

2.3 Intervention

This study evaluates the impact of terrestrial protected areas creation on rural household well-being between 2008 and 2021. These time frames were chosen on the basis of the availability of geolocalised data on household living conditions and coincide with a period of strong expansion of protected areas in the country, as shown in
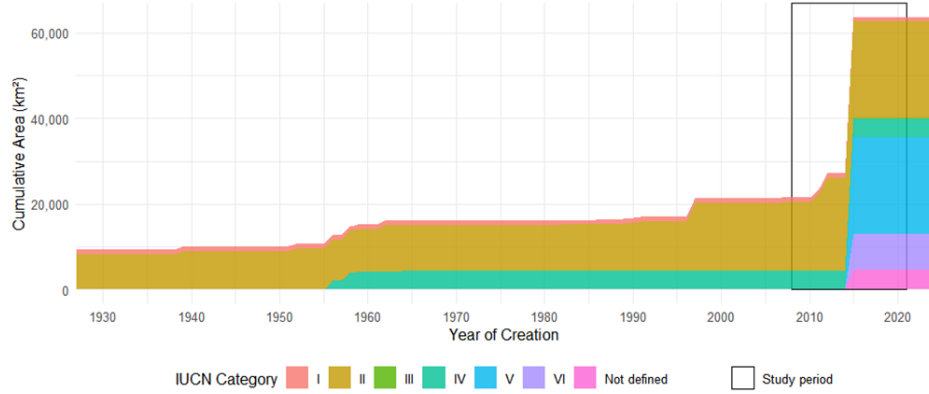

Figure 2: Evolution of protected areas in Madagascar and study period

Source:Calculations by authors based on data from the Service de la Gouvernance des Aires Protégées (SGAP) of the Ministère de l'environnement et Développement Durable (MEDD)

Protected areas in Madagascar were first created in 1927 under the French colonial administration and, until the early 2000s, were mainly characterized by strict conservation (IUCN statuses I, II, and IV). At the fifth IUCN Parks Summit in Durban in 2003, the Malagasy government committed to a tripling of protected areas. The declaration led to a wave of protected area creation, with 28 provisional creation decrees published between April 2006 and December 2007, and a global decree bringing the number of new protected areas to 97 in 2008. These decrees did not designate a manager, leaving it to the Ministry of the Environment to appoint one. This seems to have been the general practice, and managers were in place in the majority of the newly protected areas in the following years. However, it was not until 2015 that a final decree ratified these creations. Some of these protected areas were the subject of early management transfer decrees, between 2011 and 2015. Some uncertainty remains about the exact date of these early transfers, and the fact that our study period covers a wider interval (2008-2021) compensates for this inaccuracy in the start date of treatment, i.e actual conservation.

Table 1 presents the distribution of protected areas (in number and area) according to their period of designation by decree, taking 2008 as the reference year. In the treatment period (2008 to 2021), 71 protected areas were created covering 47,282 km².

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