Report

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Biodiversity Conservation—At What Cost? A Study of Households in the Vicinity of Madagascar's Mantadia National Park

An important subset of the vast number of issues associated with the conservation of tropical forests are the costs and benefits incurred by local peoples. This paper presents the results of a study of the costs borne by households living near the Mantadia National Park, a protected area in eastern Madagascar. The villages in this region are subsistence economies that are based on swidden agriculture and forest product collection. Village communities have lost access to more than 800 ha of agricultural lands and to a significant amount of forest products as a result of the park. The net present value of costs to the average household because of protection is USD 419. The analysis undertaken also provides useful information about geographic variations in the costs borne.

Swidden agriculture in Eastern Madagascar. Photo: R. Kramer.

INTRODUCTION

Efforts to conserve tropical forests are challenged by a number of socioeconomic factors. An important subset of the complex issues associated with conservation are the costs and benefits incurred as a result of protection. Conservation results in a wide range of benefits and costs (1–3). These gains and losses accrue to a broad spectrum of people who vary by location, socioeconomic status, preferences, and time. The magnitude and distribution of benefits and costs can be a critical constraint to protection (4).

Local residents or peoples who live in the vicinity of protected areas are a particularly important group that is affected by conservation measures (5). Because of their geographic proximity, cultural and historical associations, and the likelihood that they will continue to live in the area, local residents are closely linked to protected areas in both time and space. Frequently, households make direct economic use of protected areas either by hunting and gathering forest products or by using these areas for agriculture (6, 7). The economic impact of conservation on local households is of vital consideration in evaluating the potential for successfully protecting a tract of tropical forests.

This paper presents the result of a study undertaken to assess the costs borne by local residents from the establishment of a protected area, the Mantadia National Park, in eastern Madagascar. The park's creation has resulted in households losing access to certain areas of land they previously used for swidden agriculture and for obtaining forest products. The economic implications of establishing the Mantadia National Park are evaluated by estimating the costs associated with losing access to these lands.

STUDY AREA

Madagascar is recognized to be one of the biologically richest countries in the world (8, 9). However, Madagascar is economically very poor. It is also rapidly losing its extraordinary natural wealth to important subsistence needs, particularly food production. Recognizing that Madagascar's unique natural heritage needs to be conserved, the Malagasy Government has begun establishing a system of parks and protected areas.

The Mantadia National Park is one of Madagascar's four national parks. It extends over an area of 9875 ha representative of the eastern rain forests. It contains the habitat for the indri, the largest known extant lemur in Madagascar (10). Though several villages lie within a short distance (1–8 km), there are no permanent human settlements within the Mantadia National Park. Most of the forested land in and around the park is under government ownership. However, villagers have traditionally used tracts of this land for a variety of purposes. Since the park was established, some villagers have been prosecuted for obtaining forest resources from within its boundaries.

A household survey conducted in 1991 provides several insights into the characteristics of the population living around the park. The average household size in the region is 4.6 persons. Most villages do not have direct access to medical facilities, running tap water, and electricity. Primary schools exist in several villages and the literacy rate in the region is relatively high at 52%. The average number of years of schooling per person, however, is only 2.36 years. The age distribution of the population surveyed indicates a high dependency ratio. The average age of the population surveyed is very low at 22 years, with 57% of the surveyed population being younger than 20 years and 37% being less than 10 years of age (11).

Villages in this region are subsistence economies based primarily on agriculture, and secondarily on the collection and consumption of different forest products. While there are two other important income generating activities undertaken in this region—timber extraction and mining, almost all households undertake *tavy*, a form of swidden agriculture commonly practiced in eastern Madagascar (12, 13). The average annual gross household income in this region is USD 279 (14). Of this income 54% comes from subsistence agriculture, 31% from the subsistence use of forest products, and the rest from other forms of labor.

Rice is the main staple. The average household grows 487 kgs of rice every year. Valued at 500 fmg (Malagasy francs) per kg, this amounts to an annual gross income of 243 500 fmg (USD 133) (15). The other important crops grown are manioc, bananas, coffee, taro, sweet potatoes, and different types of beans.

The villages in this region are also dependent on a number of

different forest products. Fuel wood and a variety of construction wood are collected on a regular basis, numerous fish and animals are foraged for consumption, and several different types of grass are used for household purposes. For example, the average household collects 6164 kg of fuel wood in a year. The total value of the fuel wood collected is 25 249 100 fmg (USD 13 759) or USD 39 per household per year. Forest plants and herbs also serve as important sources of medicine.

In summary, people living in the vicinity of the Mantadia National Park are very poor and entirely dependent on the land and forests in the area. Thus, the establishment of the Mantadia National Park has profound implications for their lives and welfare.

THEORY AND METHODS

Welfare Implications of Establishing the Mantadia National Park

The establishment of the park has resulted in a change in the total area of the land that local households have access to for agricultural purposes and for obtaining forest products. For example, suppose initially, i.e., without the park, the average household had access to T ha of land. With the establishment of the park, the household loses access to ΔT ha ($\Delta T \geq 0$) of land. As long as the household is using optimal and positive quantities of land in its production activities, the loss in accessible land has a direct impact on household production, and thereby, on household income and consumption. The change in production and consumption behavior in turn affects household welfare.

The welfare loss to the average household can be indirectly established by estimating the profits the household forgoes by giving up lands within the park. With access to T ha of land, household profits, $\Pi(T)$, equal the net returns to the household from undertaking agriculture and collecting forest products in this land. The household maximizes profits subject to a number of production constraints.

$$\Pi(T) = p_f F + p_a A - p_k K - w(L_f + L_a)$$

subject to

$$F = F(l_f, K)$$
$$A = A(L_a, K)$$
$$L_a = L_o + L_h$$
$$L_f \geq 0,\ L_0 \geq 0,\ L_h \geq 0,\ K \geq 0,\ T \geq 0,\ p_f \geq 0,$$

where F and A are vectors of forest products and agricultural goods that the household produces or collects; p_f and p_a are vectors that represent the value of forest products and agricultural goods to the household; K is a vector of capital goods used either in agriculture or in forest product collection; p_k reflects the cost of capital used; and, L_f and L_a represent labor used in forest product collection and agriculture. The wage rate is given by w. Labor used in agriculture is comprised of household labor (L_o) and hired labor (L_h). The household maximizes profits $\Pi(T)$ by choosing K, L_f, L_o, L_h, and T.

When the household loses ΔT ha of land as a result of the park, it forgoes annual profits, and, therefore, bears an annual cost $\Pi(\Delta T)$. Over time, the household bears a total cost equal to the sum of the discounted value (net present value) of profits foregone each year (16). This is given by:

$$C = \sum_{t}^{t'} \frac{\Pi_t(\Delta T)}{(1+i)^t}$$

where C refers to the net present value (NPV) of costs, $\Pi_t(\Delta T)$ refers to costs borne by the household in year t, t' refers to the last year of the household's planning horizon, and i refers to the discount rate. The NPV of costs is estimated using cash flow analysis.

The NPV of costs is a point estimate of the costs of establishing the park, i.e., C is obtained by assuming that annual foregone profits, $\Pi_t(\Delta T)$, are known and any changes in foregone profits can be predicted. However, annual profits may vary as a result of stochastic changes in agricultural and forest product yields and prices. This suggests that annual foregone profits are comprised of a known and a stochastic element, and can be defined as Π'_t:

$$\Pi'_t = \Pi_t(\Delta T;\ \theta_t)$$

where θ_t represents the random component of annual profits. Following the cash flow analysis, a risk analysis is undertaken to establish how the NPV of costs varies with stochastic variations in critical factors that affect cash flow.

Cash Flow Analysis: Assumptions and Methods

Cash flow analysis is an accounting tool used to evaluate the money value of the flow of resources to a group of people. In this study, three cash flows are developed to assess the value of the costs borne by local residents.

Based on aerial photographs and visits to the region, three geographical groups of villages around the Mantadia National Park were identified to be affected by the park's establishment. Group 1 includes the village of Vohibazaha, and Group 2 includes the *fokontony* (cluster of villages) of Volove. These villages lie to the east of the park. Group 3 consists of the southwestern *fokontony* of Falierana and Andasifahatelo. The first cash flow presents the costs of establishing the park to the average household in Group 1; the second cash flow reflects the costs to the average household in Group 2; and the third cash flow represents the costs to villagers in Group 3 (17).

The cash flows estimate the net present value of costs by evaluating the flow of foregone benefits from swidden agriculture and forest product collection to the average household and subtracting from it labor and capital costs. Each cash flow consists of two sets of estimates of foregone benefits: i) an initial year (1991) estimate of the net cash flow to the average village household from the harvesting of forest products and from swidden agriculture; and, ii) the final projected cash flow, which extends from 1991 to 2010 (18). This cash flow is based on the initial year's flow of benefits and costs, but also accounts for the impact of deforestation over time (19).

Aerial photographs indicate that Group 1 villagers have lost 208 ha of agricultural land, Group 2 villagers have lost 339 ha of agricultural land, and Group 3 villagers have lost 319 ha of agricultural land because of the park. The initial (1991) agricultural benefits foregone are based on these land-loss estimates, and are calculated to be a proportion of the total annual agricultural returns to the household (20). In the years that follow 1992–2010, net agricultural benefits foregone are assumed to increase at the rate of deforestation. The forest product benefits foregone are estimated by identifying products obtained mainly from primary forests and not from secondary forests (21).

Prices used in the three cash flows are farm-gate and local market prices. In most cases, the market prices used are from the market closest to the village under consideration (22).

Risk Analysis

Risk analysis is a formalized method for introducing uncertainty into project evaluation (23). It requires first that subjective or objective beliefs be formed about the likelihood of the occurrence of various uncertain events, i.e., probability distributions are assigned to stochastic variables such as prices. This information is then used to generate a probability distribution of the project's net present value or any other summary measure. Thus, risk analysis allows for the consideration of an entire range of possible project outcomes and presents information on the likelihood of the occurrence of each outcome.

In this study, three variables are considered stochastic: the price of rice, the price of coffee, and rice yields per ha. Rice is the most important crop in the region and variations in rice yields and rice prices are likely to significantly influence the NPV of foregone land use. Coffee is an important commercial crop, and its price is influenced by changes in the world market for coffee. Coffee is also the second most important crop in villages east of the park (in terms of gross income).

Using a Monte Carlo simulation approach, 1000 iterations are run on each cash flow. In each iteration a random sample from the assumed distributions of the stochastic variables is drawn and the net present value of costs computed. This results in a probability distribution of the net present value of costs.

DATA

The data for estimating costs were obtained from the household survey undertaken in 1991 and from a number of research visits to the region in 1991 and 1992. The survey was administered to 351 households in 17 villages in the vicinity of the Mantadia National Park. Preceding the survey was a rapid rural appraisal that identified the populations that were dependent on the park. A pre-survey was used to test the survey questionnaire (24).

The household survey provided information on land-use patterns, agricultural yields, forest outputs, forest product processing, and labor use. Market information, price information, and detailed village-level information were gathered through a series of open-ended unstructured interviews. Price data on agricultural and forest products are village level prices obtained from interviews with villagers, shop owners, household and village leaders, and from published reports. Price and quantity data were standardized to obtain the mean values used in the cash flows (25). Secondary information and statistics were obtained from different government agencies.

The primary data used to establish the costs to each group differ between the three cash flows. However, the secondary data used are common to all three cash flows. For example, agricultural labor-use data were unavailable at the household level and are common to all three cash flows. Parameter values, such as the discount rate and the foreign exchange rate, are also common across the cash flows.

Data on land-use patterns and areas cleared within the park were obtained by mapping 1991 aerial photographs of the park. The dot-grid method was used in making the calculations. The deforestation rate for forests in the park was estimated based on a study of the deforestation history of the region (26).

The data used in the risk analysis and the underlying assumptions are presented in Table 1. The mean values used for the three stochastic variables are the same as the values used to obtain the point estimates. The coefficients of variation used to estimate standard deviations, the correlation coefficient, and the probability distributions specified for each of the three stochastic variables are based on historical data (27). Historical data at the regional level were available for a 13 year period.

RESULTS AND DISCUSSION

Table 2 presents the net cash flow from forest products and agricultural products to the average household in the year 1991. The net cash flows represent the annual profits foregone by the average household as a result of the park.

The net cash flows presented in Table 2 are not equal to the annual total household income from agricultural production and forest product collection. Approximately 18% of the agricultural land used by the average household in Group 1 and 19% in Groups 2 and 3 lies within the park. Therefore, only 18–19% of annual agricultural income is estimated to be foregone as a result of the park. For household forest products 25% related income for Group 1 and 52% and 53% of forest product related income for Groups 2 and 3 is associated with the park —the remaining income is obtained from secondary forests near the villages.

Table 2 suggests that there are significant locational differences in the costs borne by households as a result of the park. The net annual income from forest products ranges from USD 8 for Group 1 to USD 57 for Group 3. The net annual agricultural income from the park ranges from USD 7 for Group 3 to USD 22 for Group 2.

The three groups also differ in the types of demands they make on the park. Groups 1 and 2 benefit from agricultural lands within the park more than they do from forest products. However, Group 3 benefits considerably more from forest product collection. This can be partially attributed to the share of forest products obtained from within the park. There is also a larger market for forest products in areas south of the park, which results in higher prices and in higher cash flow estimates.

Table 3 presents the net present value of the costs of establishing the Mantadia National Park to the average village household in each of the three groups of villages.

In all three geographical locations, the average household bears losses in use values from the establishment of the park. Cash flow analysis indicates that with a 11.5% discount rate and a 2% deforestation rate the net present value of costs per household from establishing the Mantadia National Park is: USD 240 for Group 1, USD 427 for Group 2, and USD 564 for Group 3. Thus, in light of the extreme poverty of the households living in the vicinity of the Mantadia National Park, the establishment of the park imposes a significant burden on the average household in the region.

Geographical variations exist in the costs of establishing the park. The NPV of costs per household differs within the eastern region (Groups 1 and 2), and between the east and the southwest (Group 3). On average, the establishment of the Mantadia National Park imposes much heavier costs on villages to the southwest of the park relative to villages to the east of the park. As before, this

Table 1. Risk analysis : Data and underlying assumptions.

Variables	Mean per household			Std Dev	Coefficient of variation	Correlation
	Group 1	Group 2	Group 3			
Paddy yields (kg)	566	554	400	319	0.21	0.68
Paddy prices (fmg)	500	500	50	75	0.66	0.68
Coffee prices (fmg)	800	800	900	267	0.56	–

USD = 1835 fmg

Table 2. Value of benefits foregone from forest product collection and agricultural production in 1991.

Village	Value of forest product benefits foregone by the average household in 1991 (USD)*			Value of agricultural benefits foregone by the average household in 1991 (USD)*		
	Cash in	Cash out	Net cash flow	Cash in	Cash out	Net cash flow
Group 1	9	1	8	26	11	15
Group 2	27	6	21	34	12	22
Group 3	69	12	57	24	17	7

*An exchange rate of 1835 fmg/1 USD has been used.

can be attributed partly to the higher dependence of the south-western villages on the park and partly to the higher value of forest products in this region.

The choice of the discount rate has important implications for the estimated costs of establishing the Mantadia National Park. Estimates of the discount rate used by the households in the region are difficult to obtain and range from the official national bank rate of 11.5% to as high as 100% (28). Therefore, two different discount rates (11.5% and 25%) are used in this analysis. The lower discount rate of 11.5% results in an increase in the NPV of costs for each of the three groups of villages by approximately 50%.

Significantly, the choice of the rate of deforestation is not as important for understanding variations in estimated costs. The 2% deforestation rate reflects the rate of population growth in the region and the 4% rate reflects the historical rate of deforestation (11, 26). Using a 4% deforestation rate instead of 2%, changes the cost estimates by only 1 to 12 percentage points.

The results of the risk analysis from the Monte Carlo Simulations are presented in Table 4. Table 4 presents the mean value, minimum value, maximum value, range, standard deviation, and probability estimates of the net present value of costs for each sub-group.

Incorporating risk into the analysis allows us to consider how variations in key factors might affect the point estimates of NPV obtained from the cash-flow analysis. The expected mean NPV estimates range from USD 262 in Group 1 to USD 584 in Group 3. The estimated mean values differ by less than 10% from the point estimates obtained in the cash flow analysis. However, the risk analysis indicates that the net present value of costs lie within a wide range of values: from USD 10 for Group 1 to USD 4118 for Group 2. The high standard deviations also suggest that there is a great deal of variation in the probable NPV of costs—this is especially true of Group 2. Interestingly, the probability of the NPV of costs being greater than USD 500 is less than 15% for Group 1, but is as high as 30% for Group 2, and 55–60% for Group 3. Thus, not only is the mean NPV of costs higher for Groups 2 and 3 relative to Group 1, but the range of probable net present value of costs is also higher.

Table 3. The NPV of costs borne by the average household.

Village	Deforestation rate per year in %	NPV of costs per household 1991–2000 (1991 USD)	
		i = 11.5%	i = 25%
Group 1	2	240	121
	4	273	129
Group 2	2	427	221
	4	473	232
Group 3	2	564	317
	4	577	320

Table 4. Risk analysis of the cash flows.

Categories	Group 1 (USD)*	Group 2 (USD)*	Group 3 (USD)*
Mean NPV of costs	262	461	584
Minimum	10	116	375
Maximum	1674	4118	2012
Standard deviation	212	313	186
Prob NPV > 0	100%	100%	100%
Prob NPV > Point estimate of NPV*	> 40%	> 40%	> 40%
Prob NPV ≥ USD 500	≤ 15%	30%	55–60%

*The discount rate used is 11.5% and the deforestation rate used is 2%.

Table 5. Aggregate net present value of costs.

Village	Population	NPV of costs per household (USD)*	NPV of costs per capita (USD)*	Aggregate NPV of costs (USD)*	*Annualized costs per household (31) (USD)*
Vohibazaha (Group 1)	521	240	57	29 561	28
Andonaka	554	240	57	31 433	28
Volove (Group 2)	775	427	95	73 705	50
Falierana and Andasifahatelo (Group 3)	1554	564	110	170 892	66
All villages	3404	419	90	305 590	49

* A discount rate used is 11.5% and the deforestation rate used is 2%

AGGREGATION

Population aggregation is an important consideration in determining the total costs to local villagers as a result of establishing the Mantadia National Park. As already noted, the three cash flows developed correspond to the average household in Vohibazaha, Volove, and Falierana and Andasifahatelo. In establishing the total cost, the average NPV values are aggregated over the population of this set of villages (29).

Adjacent to the northern border of the park is set of villages that falls within the *fokontony* of Andonaka. Because of their proximity to the park, there is a high probability that the villagers in this region would use the lands within the park if they were free to do so. Therefore, the population of these villages is also included in aggregating costs. Population estimates for all the villages under consideration have been obtained from 1992 census data (30). Population figures and estimates of the aggregate NPV of costs are presented in Table 5.

As previously indicated in Table 3, cash flow analysis suggests that the average NPV of costs per household in Vohibazaha is USD 240, in Volove USD 427, and in Andasifahatelo and Falierana, USD 564. Furthermore, assuming that the costs borne by the populace of Andonaka are identical to those borne by the people in nearby Vohibazaha, a per household value of costs of USD 240 is obtained for households in Andonaka. Assuming that people outside of these areas do not use park lands, the aggregate net present value of the costs of establishing the Mantadia National Park to local peoples is USD 305 590 (32).

There are several interesting results that follow. The NPV of costs to the average household, across all the different sets of villages, is USD 419. Furthermore, the estimated annual cost borne by the average household is USD 49 (28). Thus, a total annual loss of USD 35 895 is incurred by local peoples as a result of the Mantadia National Park.

The aggregate NPV of costs is very sensitive to changes in the discount rate. If a 25% discount rate is chosen, the aggregate NPV declines to USD 164 949, which is almost half the cost estimated when a discount rate of 11.5% is assumed.

Finally, the aggregate NPV of costs is entirely dependent on the assumptions made about the populations affected by the park. It has been assumed that every household in the villages impacted by the park loses access to certain areas of land—either in the current period or in the near future. However, if it is assumed that only 50% of these households are impacted by the park, then the aggregate NPV of costs as a result of the Mantadia National Park is USD 152 792 with a 11.5% discount rate, and USD 82 474 with a 25% discount rate.

CONCLUSIONS

The cost analysis undertaken indicates that there are significant losses that local peoples bear as a result of the park. Households on average bear an annual (net) cost of USD 49 as a result of the park, which amounts to 18% of their total gross income in

1991. If all the households in the immediate vicinity of the Mantadia National Park are impacted by the park, the aggregate NPV of costs resulting from conservation is USD 305 590.

The risk analysis undertaken reinforces the results obtained from the cash flow analysis. There is at least a 40% chance that the costs are greater than the point estimates obtained from the cash-flow analysis. Risk analysis also indicates that there is a very wide range of values within which the costs can fall.

The value in undertaking this empirical exercise is to understand both the extent of the burden local residents have to bear as a result of conservation efforts, and to establish the relative differences in the burden borne. For policy decisions, the relative magnitude of the costs is perhaps more important than the absolute value of the costs. The analysis undertaken shows that costs vary according to geographical location. The largest burden is borne by villages that lie to the southwest of the park. Furthermore, different groups of villagers place different types of demands on the lands within the park. The value of forest products in the park is much higher for households in the southwestern region relative to households who live close to the northeastern borders of the park.

This paper has focused on the costs borne by local residents as a result of conservation. However, protection entails both costs and benefits. A full accounting of the benefits and costs of conservation would include amenity, non-use, and environmental values associated with the land and forests conserved. The household survey undertaken in this study did not suggest that households obtained any nonuse or amenity benefits from the park. However, there may be benefits from the environmental services provided by the forests in the park, such as flood control, that accrue to local communities.

The cost estimates presented in this paper represent a minimum value of the benefits required to make the park into an economically viable enterprise. The costs also represent the benefits required to make the park into a protected area that is accepted by local residents. Managers of integrated conservation and development projects in Madagascar are currently striving to find a balance between conservation and the satisfaction of local needs. The analysis presented in this paper shows, in very concrete terms, why local residents often resist conservation efforts. The magnitude of the costs suggests that the stakes are very high for local residents: if they are not actively involved in the planning of national parks and reserves, conservation efforts are unlikely to succeed (33).

References and Notes

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14. The exchange rate used is fmg 1835/1 USD.
15. The farm gate price of rice is used.
16. Two commonly-made simplifying assumptions have been adopted in order to keep the empirical analysis manageable. It is assumed that household production and consumption decisions are made sequentially and that the discounted sum of foregone annual profits equals the total value of the profits foregone if the household were maximizing a lifetime profit function.
17. Primary data on Andasifahatelo and Faliernana were unavailable. Therefore, in the third cash flow, data from respondents from villages to the south of the park are used as a proxy.
18. A 20 year project period was chosen because: i) a 20 year planning period for the park seems necessary to fully assess its impact; and ii) beyond 20 years discounted monetary benefits are so small that they do not add much to the net present value of costs.
19. The cash flows incorporate increases in agricultural benefits foregone because of likely deforestation over time. However, the cash flows are not adjusted for substitution activities likely to be undertaken over time. For example, households that no longer have access to hardwoods in the park (which are traditionally used for house construction), may replace these for timber species obtained in secondary forests. Lack of information on the direction and extent of substitution activities made it more appropriate to make the assumption of no substitution, rather than speculate about how substitution might occur. However, not incorporating substitution effects may mean that the cost estimates are biased upward.
20. Agricultural benefits foregone as a result of the park are obtained by considering the percentage of the total land used or controlled by the household that currently lies within the park boundaries.

$$\%\ Agricultural\ benefits\ foregone = \frac{total\ agricultural\ land\ controlled\ within\ park}{total\ agricultural\ land\ controlled}$$

21. Because not all households understood where the park boundaries were, households were asked whether they obtained their forest products from primary or secondary forests. All products obtained from primary forests were assumed to have come from within the park.
22. Because there are relatively few buyers and sellers for several of forest products, market prices are to be treated as second best estimates of true marginal values.
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24. The survey instrument was tested by conducting a pre-survey of 25 households (7% of the sample) in the village of Farahevitra.
25. The conversion factors used and their sources are available in Shyamsundar (11).
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27. Probability distributions are specified for each of the three stochastic variables based on the distribution of historical data. The Kolmogorov-Smirnov (K-S) test was used to test the hypothesis that the empirical distributions fit a lognormal distribution. The null hypothesis could not be rejected at the 95% confidence level for any of the three chosen distributions.
28. The 11.5% discount rate is based on 1989 financial statistics on Madagascar published in *International Financial Statistics, Year Book 1991*, International Monetary Fund, USA.
29. Not every household in these villages uses lands within the park. However, their proximity to the park makes it highly likely that these households would use the park area if they were not forbidden to do so.
30. These data were obtained directly from government offices in Andasibe and Ambatavola.
31. The annual values have been calculated using the following equation:

$$\text{Annual costs} = \text{Estimated NPV} \cdot \left[\frac{i(1+i)^{20}}{(1+i)^{20}-1}\right]$$

32. People in other regions are unlikely to use lands within the park in the future. This is because the lands in the park that are accessible are land locked by villages that surround them.

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