

CONSERVATION VERSUS DEVELOPMENT AT THE IGUACU NATIONAL PARK, BRAZIL¹

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Abstract

The Iguacu National Park is a conservation unit that protects the largest remnant area of the Atlantic Rainforest in Brazil. The Colono Road is 17.6 km long road crossing the Iguacu National Park that has been the motive of dispute between environmentalists, government bodies and NGOs defending the closure of the Colono Road; and organised civil institutions representing the population of the surrounding cities defending its opening. In October 2003, 300 people invaded the Park in an attempt to remove the vegetation and reopen the road, which was prevented by members of the Brazilian Army and Federal Police. Those who advocate the reopening of the Colono Road claim significant economic losses imposed on the surrounding cities. This paper investigates this claim and concludes that a possible reopening of the Colono Road cannot be justified from an economic perspective.

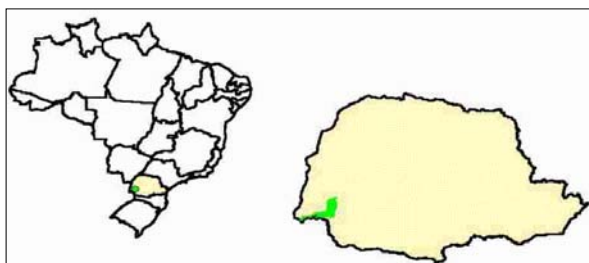
Keywords: Iguacu Park; Brazil; Colono Road; economic development; environmental degradation; valuation; cost-benefit analysis

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1. INTRODUCTION

The Iguacu National Park is a conservation unit located in Parana State, south region of Brazil (Figure 1), comprising an area of 185,000 ha. It was created in 1939 and declared a world natural heritage site by UNESCO in 1986. It is the largest remnant area of the Atlantic Rainforest in Brazil. Its flora and fauna are diversified, with more than two hundred species of animals; some of them endangered species, including a bird already extinct elsewhere (*papagaio-de-peito-roxo*). Another important ecological service provided by the forest in the park is to protect the *Floriano* river basin, among other rivers that provide water and habitat for humans and fauna in the surrounding region. The Iguacu Park is, therefore, an important conservation unit for maintaining the ecological equilibrium of the region.

Figure 1: Location of the Iguacu National Park in



Brazil and the Parana State.

IBAMA (1999)

The Colono Road (*Estrada do Colono* or *Settler Road*) is a 17.6 km road linking the cities of *Serranópolis do Iguacu* and *Capanema*, crossing the Iguacu National Park and reducing the terrestrial distance between these cities by approximately 180 km. The information about when the Colono Road was built is not precise; with some sources stating that the road already existed by the time the National Park was created. In 1954, the Colono Road was included in the Parana State road network (PR-495); and in July 1986 the road was closed following a legal

sentence. The Colono Road remained closed until May 1997 when an entity named 'Friends of the Park' (*Movimento de Amigos do Parque*) reopened it despite the court decision. In June 2001 the Colono Road was once more closed following another legal sentence, this time with the support of the Brazilian Army and other Federal Police groups. Another attempt to forcefully reopen the Colono Road occurred in October 2003, when a group of approximately 300 people invaded the Park with machines in order to remove the vegetation and reopen the road to traffic, but this time the Federal Police reacted promptly and avoided the transit of vehicles. Since then, a legal battle has been under way between organised civil institutions in favour of the reopening of the Colono Road on one side, and environmental NGOs and public institutions aiming to keep the road closed on the other.

According to Bergalo and Vera y Conde (2001), the benefits of roads are familiar to societies but their negative impacts, which may have a wide geographical impact, are not entirely known. The authors estimate that for each kilometre of road opened in a forest area the negative impacts over this habitat cover approximately 13.5 km in both sides of the road. The implementation of a road changes the physical conditions of the area and the hydrological bodies close to the area through compacting of the soil and the transfer of sediments and other materials. The dust transfers to the water ecosystems fine sediments, nutrients and contaminants, reducing the biological productivity and affecting the survival or development of fish. Even when a road is deactivated, the compacted soil persists for several years. The road traffic spreads dusts that are deposited in the vegetation leaves and can block the photosynthesis process, the respiration and

transpiration of the vegetation, changing its structure (Bergalo and Vera y Conde, 2001).

Other important impacts of roads in forest areas refer to heavy metals emitted by engines, which contaminate the soil, plants and animals; and the accidents involving animals hit by vehicles. Additionally, the fragmentation of habitats imposes a limitation to the movements of several species, affecting their population dynamics. When this fragmentation is drastic it can result in genetic isolation of populations, which is the major threat to the maintenance of species. "Considering the importance and the objectives of the Iguacu National Park, it is beyond debate that conservation is the highest priority of the area, which fully justifies the definitive closure of the Colono Road" (Urban, 2002).

However, the organised groups in the region that advocate the reopening of the Colono Road do so on the basis of an alleged significant economic loss imposed to the surrounding cities by its closure. In addition, these groups claim that the official institute in charge of Conservation Units in Brazil (IBAMA) adopts different positions in different areas, which shows inconsistency in its conservation policy. For example, there are similar cases of roads crossing Conservation Units in Brazil: the Serra da Bocaina National Park, between Rio de Janeiro and Sao Paulo, where a 9.3 km road links the cities of Paraty and Cunha; the Biological Reserve of Sooretama (Paraná); the Ecological Reserve of Taim (Rio Grande do Sul); and the Morro do Diabo State Park (São Paulo).

This paper aims to (i) identify the conflicting interests against and in favour of reopening the Colono Road; and (ii) estimate the magnitude of the potential economic costs and benefits of this decision. In order to pursue our first objective, several interviews were undertaken in December 2003 with stakeholders within the

area of influence of the Iguacu National Park (PARNA Iguacu). Official statistics and literature-based economic data were used to estimate costs and benefits of a hypothetical reopening of the Colono Road in year 2004. This study was undertaken between November 2003 and January 2004. It started two months after the last attempt to reopen the Colono Road that kicked off the ongoing legal battle between different government bodies at different levels, environmental NGOs and other civil society organisations.

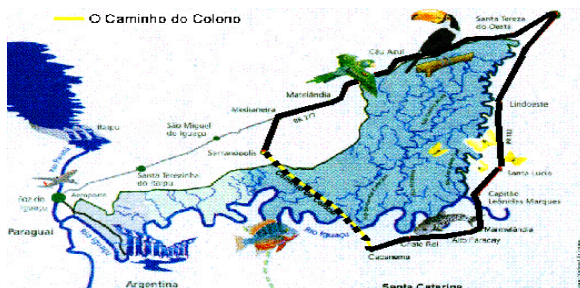
The need of a prompt answer to the question whether the economic aspect could justify or not the reopening of the Colono Road shaped the methodology used in this work. It should also be highlighted that given the limited resources available, it was not possible to develop econometric, general or partial equilibrium models, the tools that would allow analysts to evaluate the wider economic impact of a road on a region's economy. Given the impossibility to develop such a tool, the scope of this study was limited. We selected some of the direct impacts identified by stakeholders in our interviews to compose the cost-benefit analysis of the reopening of the Colono Road. Thus, our objective was to estimate an order of magnitude of these costs and benefits since we acknowledge that other potential costs and benefits could not be estimated. Results are presented in Brazilian Reais (R\$).

This paper is organised as follows: section 2 presents an overview of the economy of the region and an analysis of the Colono Road within this context; section 3 shows the procedures adopted in our interviews and the qualitative analysis results. The stylised cost-benefit analysis of reopening the Colono Road is provided in section 4, while section 5 concludes.

2. THE COLONO ROAD AND THE ECONOMY OF THE PARANA STATE

The area of influence of the park comprehends fourteen cities, five of which have part of their territories in the park: Foz do Iguacu, Sao Miguel do Iguacu, Serranópolis do Iguacu, Matelandia and Ceu Azul. Another five cities border on the Park: Santa Terezinha de Itaipu, Santa Tereza do Oeste, Lindoeste, Capitão Leonidas Marques and across the Iguacu river, Capanema. Medianeira is not a neighbour city to the Park but its waters drain to the Iguacu hydrological basin and it is the only city situated in the southwest micro region (IBAMA, 1999). Details of the Iguacu Park area of influence are given in Table 1 and Figure 2.

Figure 2: Location of the Colono Road in the Iguacu National Park.



<http://www.pr.gov.br/batebyte/edições/2001/bb116/estagiario.htm>

The economy of this area is characterised by a strong influence of the primary sector, mainly agriculture. It can be seen that in some cities the primary sector corresponds to more than 80% of the total value added. Only the city of Foz do Iguacu, which is primarily urbanised and tourism-based, does not have the primary sector participating in its economy. According to IPARDES (2003, 2006), the agricultural sector in the region is specialised in few crops, such as soybean, wheat, cassava and corn. For example, the cassava and soybean production in the area of

influence of the Iguacu National Park correspond to 27.3% and 26%, respectively, of the total Parana State production, despite the fact that the area only represents 4% of the state's territory.

Soybeans and wheat, the main crops in the region's agricultural output, are commodities of relatively low price volatility and prices influenced by international markets and demand. Another interesting characteristic of the agricultural sector in the region is that 86.9% of the rural establishments and 41% of the planted area correspond to small properties or family businesses (IPARDES, 2003). This characteristic suggests a limited capacity to expand crop areas, which restricts any potential increase in revenue to increases in the commodity prices, assuming constant productivity of factors.

The Colono Road was in good condition between 1997 and 2001, the period when it was opened to the traffic of vehicles. Although the road was not paved, its 17.6 km was accessible by regular vehicles. According to a survey undertaken by the Parana State Forest Police, the main types of vehicle using the Colono Road were tourism or passenger cars (57%), buses (24.8%) and trucks (10.4%). It shows that passenger transportation in the Colono Road corresponded to 81.7% (buses and passenger cars), whereas freight transportation represented less than 20% of the total of vehicles using the Colono Road. These results suggest that the Colono Road was not used mainly for the distribution of the agricultural goods produced in the surrounding cities, but rather mainly for passenger transportation between the Parana State southwest and west regions.

In fact, according to Urban (2002) there was intense traffic of buses from other Brazilian states (over 40% of total), most likely for the

transportation of shoppers between the city of Puerto Strossner, an important tax-free zone in the

Table 1: Area of influence of the Iguacu National Park

City	Total area (km ²)	% of city in the Park	% of Park's area in the city	Population (2000) ^(b)	Value added (%)		
					Primary	Secondary	Services
Capanema	415			18,239	59.1	21.3	6.7
Cap. Leonidas Marques	250			14,377	69.3	14.9	5.8
Ceu Azul	1,153	73.1%	49.6%	10,445	49.5	30.2	12.2
Foz do Iguacu	422	30.1%	7.5%	258,543	0.3	83.8	4.4
Lindoeste	440			6,224	83.5	8.5	5.1
Matelandia	598	56.5%	19.9%	14,344	61.8	14.7	10.3
Medianeira	314			37,827	33.1	32.8	12.6
Ramilandia	245			3,868	84.2	3.7	2.5
Santa Lucia	147			4,126	83.5	5.5	5.3
Santa Tereza do Oeste	337			10,754	82.5	6.7	4.6
S.Terezinha de Itaipu	248			18,368	39.0	32.9	9.5
Sao Miguel do Iguacu	894	11.7%	6.2%	24,432	59.1	21.4	6.8
Serranopolis do Iguacu	477	60.3%	16.9%	4,740	*	*	*
Vera Cruz do Oeste	324			9,651	77.8	9.1	4.7
TOTAL	6,268		100%	435,938	59.1	21.3	6.7

Source: IBAMA (1999); (b) IBGE (2003). (*) Not available.

Paraguayan border with Brazil and the main Brazilian capitals further north². The use of the Colono Road by shoppers' buses was later confirmed during the fieldwork undertaken in the region during the course of this work. It has been suggested, albeit subtly, that the Colono Road allowed the traders to avoid an inspection point of the Brazilian Customs (*Receita Federal*) located in

the city of Medianeira, which could facilitate the eventual transportation of illegal or undeclared goods.

3. THE FIELDWORK

The limited resources available for this study did not allow us to undertake a survey of a representative sample of the population in the region. Instead, we have identified and interviewed the relevant stakeholders that were representative of the main social groups potentially affected by the Colono Road issue such as local politicians, the Park administration, government and NGOs representatives. In addition, several other informal interviews were undertaken in loco with businessmen, policemen and family farmers in order to have an idea of the

² Small informal traders (locally known as *sacoleiros* or *ambulantes*) have always been very popular in Brazil, especially among unemployed or unskilled workers. Their activity consists of buying light imported goods (e.g. electronic gadgets, alcoholic drinks, cigarettes *etc*) and reselling these goods either among their acquaintances or in small tents organised on the streets of the main Brazilian cities. The Paraguayan city of Puerto Strossner is perhaps the most popular origin of these goods for the Brazilian market because it concentrates a large amount of tax-free shops and the city can be reached by road transportation, which reduces significantly the transportation costs for these informal traders.

general feeling of the population about the Colono Road issue. The interviews occurred between 15 and 19/12/2003.

Prior to the interviews, a literature review and press search identified the main reasons given in favour and against the reopening of the Colono Road (Table 2).

3.1 QUALITATIVE ANALYSIS

We have interviewed, among others, leaders of AIPOPEC (see annex for a list of acronyms), a civil entity mainly formed by local politicians and that claims to represent the interests of the population bordering the Iguacu

Table 2: Main arguments in favour and against the reopening of the Colono Road

In favour of reopening the Colono Road:
Economic: severe financial losses imposed to the Parana State west region
Socioeconomic: population and business experienced negative growth while the road remained closed
Historical: the migration to the southwest region occurred at the beginning of the 20 th century; the "Coluna Prestes", a communist attempted revolution led by Carlos Prestes (1924) which passed the Colono Road.
Cultural: a major difficulty for families to visit their relatives on the other side of the Park.
Against the reopening the Colono Road:
Loss of or damage to the flora.
Facilitating the hunting or killing of animals in the interior of the Park.
Fragmentation of forest areas, isolating the west region of the Parana State.
Soil compacting with negative consequences to hydrological bodies.
Indirect impacts such as noise and non-degradable garbage.

National Park. However, the most striking and illegal activities, such as the invasions of the Park and the operation and toll collection when the Colono Road was open between 1997 and 2001, were led by "Friends of the Park", an underground organization formed "by the people". Obviously, no member of this entity could have been identified for an interview. According to representatives of AIPOPEC, their entity tries to "mediate" negotiations between "Friends of the Park" and other organisms such as IBAMA, the Federal Police and prosecutors.

An interesting aspect observed during the fieldwork regards the homogeneous discourse among the two groups of interest, those who want the road open - mayors and members of AIPOPEC; and those who want it closed - representatives of IBAMA, NGOs and

environmentalists. We summarise below their main points.

The Iguacu National Park and the population

We have identified that the relationship between the Iguacu National Park and the population of the surrounding cities (

Figure), especially in Serranópolis do Iguacu, is not always smooth: several interviewees referred to the conservation unit as an obstacle to the region's economic development. These people still have the perspective of the frontiersman, the settler who occupied the region in the past and slashed the forest for agricultural use³. This cultural aspect would be at the centre of the problem related to the Colono Road: "without the road the park is an enemy of the people". Although several stakeholders agreed that the

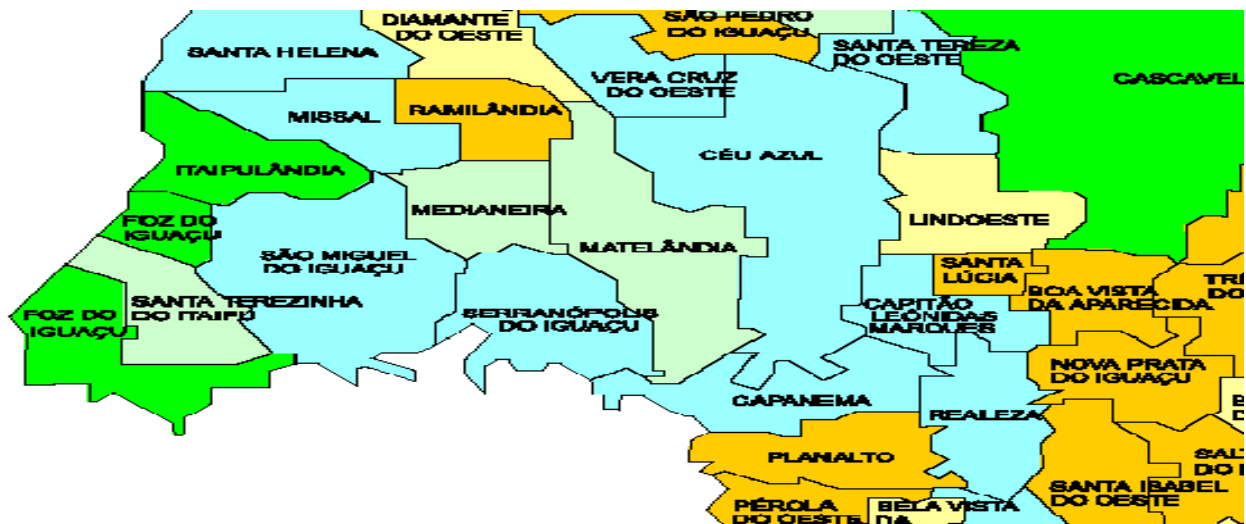
³ See Colombo (2001) for a description of the occupation of the region.

region's economy would not be heavily impacted with the reopening of the road, it is argued that the collective consciousness of society associates the economic stagnation observed in the region with the closure of the Colono Road. "There is a sense of loss; something must be done to improve the image of the Park among the population".

Another argument identified as part of the problem relates to family and cultural links

between the residents in Capanema and Serranópolis do Iguacu. There are reports of people who do not visit their relatives for more than a year because the alternative without the Colono Road is expensive for farmers and their families. Another cultural link mentioned is a festival held annually in Capanema, a social event much appreciated by residents in Serranópolis do Iguacu who can no longer attend the party for economic reasons. This cultural aspect contributes

Figure 3: Location of municipalities in the Area of influence of the Iguacu Park



IPARDES (2003b)

for a certain dose of animosity against the presence of the Iguacu National Park in the region.

The Colono Road and the population

According to AIPOPEC, it is believed that popular support for the associations that advocate the reopening of the Colono Road is considerable; especially in Serranópolis do Iguacu, Medianeira and Capanema. It was also mentioned that Capitao Leonidas Marques is another city where there is considerable outrage at the closure of the Colono Road. However, several other stakeholders believe that popular support is much smaller. For example, environmental NGO representatives

state that the Colono Road "is a concern of small isolated groups, it is not the will of the population". There were also reports of complaints from some residents of Serranópolis do Iguacu: "I lent my tractor to open the road and then they charged me a toll to use the road".

Agents of the Brazilian Federal Police camped at the entrance of the National Park at Serranópolis do Iguacu since the attempt to reopen the Colono Road in October 2003 are well accepted and relate well with the population of Serranópolis do Iguacu. According to some of these agents, "the local population is preservationist but is backing the opening of the

Colono Road for cultural reasons; parents are divided by the Park". It can be concluded that there is a real popular demand for the reopening of Colono Road, particularly in Serranópolis do Iguacu and Capanema, and to a lesser degree in Medianeira and Capita Leonidas Marques. For other towns it was not possible to clearly identify such demand.

How the Colono Road was used when opened between 1997 and 2001

The fieldwork confirmed that there was substantial traffic of vehicles on the Colono Road, especially tourist buses, passenger cars and some trucks. The road was open from sunrise to sunset and on average 280 vehicles circulated on it per day. As for freight, although not significant, AIPOPEC mentioned that there were restrictions on the movement of live, toxic, flammable, hazardous, chemicals and/or dangerous goods. However, there were reports that in addition to soybeans, corn, poultry and pork, the road was used by tanker trucks for transportation of fuels.

There was no dispute concerning the information that cars stolen in Brazilian cities circulated on the Colono Road heading to Paraguay. Everyone recognizes that this is a common problem in the region as a whole (cars stolen in Brazil being negotiated in Paraguay), but this could be easily controlled by the authorities due to the characteristics of the Colono Road. The seizure of drugs in the Colono Road has been confirmed on a couple of occasions, as well as the frequent use of the road for the passage of (tax-evaded) goods from Paraguay to the Brazilian market. Another important citation indicated that the Colono Road facilitated other illegal activities such as hunting and cutting of palm trees within the Park. These illegal activities continue to exist without the Colono Road being open, but the

open road facilitated access within the National Park.

Pro-Colono Road activists claim that several small businesses experienced significant reduction in their activities during the period when the Colono Road remained closed between 1986 and 1997, such as hotels, bars and restaurants, and petrol stations. According to AIPOPEC (1999), in three and half years (1997-2001) when the Colono Road remained open, the economy of Capanema almost doubled; the negative population growth (4-5%/year) was stabilised; the number of business licenses issued by the city almost tripled; the number of businesses increased from 25 to 85. In summary, the information described in this section seems to suggest that the main economic sectors in the surrounding cities that somehow could be affected by the permanent closure of the Colono Road are tourism and small services. For example, one restaurant in Serranópolis do Iguacu used to sell an average of 90 to 100 meals per day and during this fieldwork it was selling no more than 10 meals per day. To put this into perspective, the losses from this business were estimated at approximately R\$ 500 per day. This establishment employed three employees when the Colono Road was closed and was on sale during the period of this fieldwork. Another example is a restaurant in Capanema, which according to its owner, served between 160-180 meals a day and after the road was closed served between 70 and 80 meals per day.

Who would benefit from the reopening of the Colono Road?

It was consensual among respondents that the main benefit (economically) from a possible reopening of the Colono Road would be for small businesses in Serranópolis do Iguacu and Porto Lupion, Capanema. Gas stations,

restaurants, garages and hotels would be those institutions most likely to develop as a consequence of the reopening of the road. However, some believe that all businesses in Serranópolis do Iguacu, Capanema and Medianeira would be indirectly and positively impacted.

Regarding the agricultural producers, it is believed that they would not be affected since the production on both sides of the Colono Road is transported eastward to the port of Paranaguá, especially soybeans. The markets receiving the agricultural production of Capanema are Pato Branco and Francisco Beltrão, while production of the west (Serranópolis do Iguacu), in general, goes to cooperatives in the region or to Cascavel. In both cases the Colono Road is of no use for transporting agricultural production in the region.

Expectations for the future

Some interviewees mentioned the possibility that the population might set fire to the forest in the National Park in case the Colono Road remains closed. There were different expectations among stakeholders in this regard. AIPOPEC believes that the threats of the population are serious while representatives of IBAMA do not believe in this possibility: "if they wanted to set fire in the Park they would have already done it".

For IBAMA, the next steps include the resumption of dialogue, the development of projects of environmental education and ecotourism in the surrounding cities, and to provide support for organic agriculture in the region: "IBAMA will have to present an alternative and reopen the discussion ... an alternative can be a monorail, a suspended train for transporting passengers and goods that does not occupy the soil".

On the other hand, AIPOPEC proposed the adoption of some measures that would reduce the environmental impacts of the opening of the Colono Road. They are: (i) opening of the road only during the day; (ii) prohibiting the movement of live loads, toxic or flammable goods; (iii) distribution of plastic bags for garbage and educational material in the entrances of the road; (iv) the implementation of environmental education programs in public schools; (v) the development of conservationist economic activities in the vicinity of the National Park such as production of hearts of palm and eco-tourism.

4. COST-BENEFIT EXERCISE

One example of a previous similar analysis of the economic impact of the Colono Road was given in AIPOPEC (1999), which cites two studies that analyzed how economic growth in a selected group of cities in the region was affected by the closure of the Colono Road. The results presented were controversial. For example, Capanema, whose in 2003 had a GDP of approximately R\$ 38.5 million appears as experiencing accumulated losses equal to R\$ 300 million⁴.

The task of identifying the socio-economic impacts of a road in a given region is not trivial. The economic literature suggests the use of general or partial equilibrium models to measure the possible direct and indirect impacts of an intervention on the economy of a region. Given the short period of time for undertaking this study and also the difficulty of obtaining data to estimate the supply and demand curves in the economy of the region, we were forced to use simplified (but correct) alternatives to provide indicators of socio-economic impacts of the Colono Road.

⁴ Oliveira (1999), analyses this study in detail.

Because of these uncertainties surrounding economic estimates, particularly in this case in which the available information is conflicting and controversial, we seek in this study to work with orders of magnitude. Therefore, we seek to identify the magnitude of the main socio-economic impacts of the Colono Road in the Area of Influence of the Iguacu Park and compare it with the order of magnitude of the estimated value of environmental degradation in the Iguacu National Park. To this end, the following hypotheses are assumed: (i) since the Colono Road was closed in the end of 2003, we assumed the hypothesis of the road coming into operation in January/2004 and remaining open throughout the year 2004. The goal was to compare costs and potential private and social benefits only in 2004, thereby avoiding the arbitrary choice of a discount rate; (ii) we did not attempt to estimate all possible costs and benefits involved in an opening of the Colono Road, but those direct impacts that were mentioned by stakeholders during the fieldwork, such as changes in production costs of some goods; tax collection; toll revenues and the costs associated with environmental degradation.

4.1 BENEFIT: REDUCTION OF AGRICULTURAL PRODUCTION COSTS

Initially, it was believed that a reduction in agricultural production costs could be the main benefit (in economic terms) of a possible reopening of the Colono Road. By shortening the trip between Serranópolis do Iguacu and Capanema by approximately 200 km, this would represent a significant reduction in transport costs for some products and, consequently, could reduce their production costs. If this production cost reduction could pass on to market prices, there could be an impact on the demand for

agricultural products, depending on price elasticities. However, after the literature review and fieldwork it was observed that the productive structures of both cities are very similar, with an emphasis on agricultural production of soybean, corn, wheat and poultry. In fact, the same is true when comparing the productive structures of the West and Southwest regions of Parana state. Therefore, it was not possible to identify products produced in one region that could be marketed in the region at the other end of the Colono Road.

When considering products transported from other regions such as Sao Paulo and Mato Grosso do Sul to the south region of Brazil, it was not possible to identify products that could have their production cost reduced by the shortening of distance between the markets. Moreover, the impact of shortening the distance due to the Colono Road tends to be lower the longer the distance for the transport. Due to the above, it is believed that the reduction in transport and production costs caused by a potential reopening of the Colono Road would be negligible, certainly in the short period relevant to this study (1 year).

4.2 BENEFIT: TAX REVENUE

An increase in economic activity generally leads to increased tax revenues. Again, without the use of general equilibrium models it is difficult to predict the impact that the opening of the Colono Road could have on the local economy and, consequently, on the collection of municipal taxes. However, some considerations can be made on the subject.

The management plan of the Iguacu National Park identified the importance of transfers and taxes on the region: "The imbalance between funding and investment in all municipal budgets is clear. The economic capacity of the

fourteen cities, as well as other cities in the state of Parana, is more dependent on transfers of the federal and state governments as well as the green-ICMS (see below) than their own revenues, with the exception of Foz do Iguacu" (IBAMA, 1999)⁵.

The tax with the greatest potential to increase revenues in the event of a possible opening of the Colono Road is probably the Tax on Circulation of Goods and Services (ICMS – *Imposto sobre Circulacao de Mercadorias e Servicos*). This is a state tax, calculated on the distance travelled within the State of Paraná, and distributed proportionally among cities, again with respect to the distance travelled in each region. For example, in the absence of Colono Road, goods produced in the northwest of Parana or in Mato Grosso do Sul heading to the south or southwest of Parana would not pass via Capanema and Serranópolis do Iguacu, so these cities would have their shares of the ICMS revenue reduced. However, other cities along the alternative path(s) would benefit and due to the longer distance to get around the Iguacu National Park would generate a higher value of ICMS for the same transportation.

Admitting only those cities most clearly identified as those that would directly benefit from the opening of the Colono Road in terms of ICMS revenue (Capanema, Medianeira and Serranópolis do Iguacu), and ignoring those cities that would eventually be negatively affected in terms of ICMS revenue, we estimate the tax revenue for these cities in case the Colono Road was open during 2004. The data available were for the year 1997,

when the Colono Road was reopened in May, for all the cities studied. In 1999, when the road was still in operation, and for the year 2003 - when the road was again closed - the data are only available for the city of Capanema. Given the data limitations mentioned above, we adopted the following procedure to estimate an approximate value of the benefit of opening the Colono Road in terms of ICMS revenue:

- a) We estimated the annual growth rate of ICMS revenue between 1997 and 1999 for the city of Capanema;
- b) We assumed the same growth rate in this period to project the ICMS revenue in 1999 to Serranópolis do Iguacu and Medianeira;
- c) We estimated the annual growth rate of ICMS revenue between 1999 and 2003 for all cities (period with the road closed);
- d) We forecast the ICMS revenue for year 2004 using the annual growth rate in the period when the Colono Road was open (1997 - 1999) and using the growth rate observed between 1999 to 2003 (road closed after June 2001);
- e) The difference between the forecasted values using both growth rates represents an approximation of the additional amounts collected by the cities in case of reopening of Colono Road. Table 3 summarises the results.

The above exercise is obviously quite limited because of the adoption of several simplifying assumptions to compensate the lack of more accurate data. However, as mentioned earlier, our aim was to obtain an indicator of the magnitude of this benefit, which can be inferred from the figures presented. The results indicate that the share of the ICMS collected by the cities that are likely to benefit from the opening of the Colono Road would be approximately **R\$1.3**

⁵ An anonymous referee observed that several municipalities in this area also receive compensation payments for the electricity produced at Itaipu Binacional hydroelectric power plant, perhaps the largest single source of municipal revenue in the area. However, this revenue would not be affected at all by the Colono Road.

million in 2004. This figure is overestimated, since it does not consider that other surrounding cities would experience loss of ICMS revenues for the reasons mentioned above; and any potential losses in their respective shares of the green-ICMS, as explained below.

The ecological or green-ICMS is a tax passed on to cities by the Paraná State, aiming to compensate some cities for having land covered by conservation areas. Table 4 shows that the cities bordering the Iguacu National Park receive

approximately **R\$ 7 million** in ecological ICMS annually. Serranópolis do Iguacu and Ceu Azul are the cities that benefited most from the green-ICMS. Serranópolis do Iguacu received in 2002, about R\$ 1.5 million, representing almost 70% of the city's revenue (Andersen, 2003). It should be mentioned that the collection of the green-ICMS could be negatively affected by the reopening of the Colono Road since this transfer depends on the protected area within the city, and indices of environmental quality, which could be reduced as

Table 3: ICMS tax revenue (R\$)

	Capanema	Serranópolis do Iguacu	Medianeira
1997 ^(a)	1,174,491	446,043	2,170,946
1999	1,816,912	690,018 ^(b)	3,358,406 ^(b)
(1) Annual growth rate between 1997 and 1999, Colono Road open	24.4%		
2003 (budget)	2,507,500	952,287 ^(b)	4,634,897 ^(b)
(2) Annual growth rate between 1999 and 2003, Colono Road closed after 2001	8.4%		
2004 (projected using rate 1)	3,118,767	1,184,431	5,764,772
2004 (projected using rate 2)	2,717,801	1,032,154	5,023,621
Difference	400,966	152,277	741,151

(a) IBGE (2003); (b) estimated;

Table 4: Distribution of the green-ICMS in the area of influence of the Iguacu Park (R\$)

City	2001	2002	2003 (until July)
Capanema	186,944	247,552	168,721
Capitao Leonidas Marques	56,801	62,082	42,312
Ceu Azul	1,810,264	1,889,310	1,074,769
Foz do Iguacu	872,798	953,942	650,167
Lindoeste	88,090	96,280	65,620
Matelandia	1,338,433	1,397,451	796,401
Medianeira	33,129	34,208	23,002
Ramilandia	12,298	107,587	85,205
Santa Lucia	30,851	33,719	22,981
Santa Tereza do Oeste	115,871	126,643	86,314
Santa Terezinha de Itaipu	87,880	80,004	54,673
Sao Miguel do Iguacu	340,567	357,180	206,161
Serranopolis do Iguacu	1,498,891	1,564,062	889,050
Vera Cruz do Oeste	124,543	127,260	95,549

Total	6,597,366	7,077,286	4,260,934
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Adapted from internal documents from PARNA Iguacu administration.

a consequence of the road⁶. We opted for not accounting for this potential loss of revenue due to the high uncertainty such estimate would comprise (the methodology used for estimating the share of green-ICMS was not available to the author).

4.3 BENEFIT: ROAD TOLL REVENUE

When the Colono Road was in operation between 1987 and 2001 a road toll was charged, introduced by "Friends of the Park". According to data from AIPOPEC, the money raised at the toll point was used to pay the eight employees, the maintenance of the road, the operation of a boat to cross the Iguacu River and a lawyer. Despite the illegality involved in this operation - the toll charged by a private entity in a State road without a formal concession issued by the competent body – we assumed that the revenue obtained with the toll was a benefit obtained with the operation of the road and that this procedure would be maintained in a possible reopening of the Colono Road, regardless of who might operate it.

Assuming that the percentages per type of vehicle remained constant over time, and using data about the daily average of vehicles⁷, we

estimated the approximate number of vehicles using the Colono Road when it was closed in 2001. During the fieldwork, representatives of AIPOPEC confirmed that the toll was R\$ 5 for passenger cars, R\$ 12 for small trucks (1 axis) and buses, and R\$ 15 for larger trucks. The calculation of the total amount collected with toll in the case of a reopening of the Colono Road was done by taking those values collected in 2001, correcting these values using the Brazilian consumers' price index (IGP-M) until November 2003 and multiplying by the average number of vehicles using the road in 2001. As can be seen in Table 5, the annual amount collected from the toll in the event of a reopening of Colono Road would range between **R\$ 1.2 - 2.2 million / year**.

4.4 COST: ENVIRONMENTAL DEGRADATION

From the economic point of view, the relevant value of an environmental asset is the value that is important for decision making; i.e. the value of an environmental resource is the contribution of the resource to social welfare. Economic valuation techniques aim at assessing the economic value of an environmental resource through the determination of what is equivalent in terms of other resources available in the economy; i.e. what we would be willing to give up in order to obtain an improvement in quality or quantity of the environmental resource. Economists estimate environmental values in monetary terms in order to make this value comparable with other market values, allowing

⁶ An anonymous referee correctly pointed out that the basis for allocation of this tax revenue among municipalities is the state-wide protected area and environmental quality indices. While there could conceivably be some loss due to increased threat to the integrity of the park, the environmental quality indices are not likely to be seriously affected unless IBAMA does nothing additionally to protect the park in the presence of the Colono Road. This argument reinforces our decision of not including the green ICMS revenue in our cost-benefit analysis.

⁷ There is no precise information about the exact daily number of vehicles crossing the Colono Road when it was closed. Very different numbers were reported by different sources, always crediting the information to

AIPOPEC. These numbers range between 300 and 500 vehicles per day. However, during a personal interview with a representative of AIPOPEC this number was confirmed as approximately 280 vehicles/day.

decision making involving environmental resources⁸.

The total economic value of an environmental asset comprises the sum of use and non-use values of environmental resources. Use values include the sum of the direct use values, indirect use values and option values. The use value of an environmental asset is derived from the use or consumption of the resource. The same environmental resource can have several different uses and thus have multiple direct use values. Indirect use values are those coming from the ecological functions of the environmental resource. For example, the well-being indirectly derived from a forest (water quality, clean air, scenic beauty, *etc.*) represent the indirect use value of the forest. Option values relate to the amount that individuals would be willing to pay to maintain the environmental resource for future use. That is, there is no use, direct or indirect, in the present, but there may be use of the resource in the future. Non-use value of an environmental resource is related to the personal satisfaction in knowing that the resource is there, without the individual having direct or indirect advantage of its presence. For example, some people may be willing to pay for avoiding deforestation of the rainforest, even though these people never come to visit the forest or consume any of its products.

Use value

The travel cost method estimates the recreational use value of a site through the

⁸ On the other hand, monetary arguments are far from being the only determining factor in deciding whether to invest in protecting environmental resources, which have intrinsic importance on qualitative grounds.

Table 5: Estimates of toll revenue in the Colono Road (R\$)

Type of vehicle	Toll fare (adjusted to 11/2003)	Daily average (minimum)	Daily average (maximum)	Toll revenue (minimum) (R\$)	Toll revenue (maximum) (R\$)
Buses	17.19	69	124	1,186	2,131
Trucks	21.49	29	52	623	1,117
Cars	7.16	160	285	1,145	2,040
Vans	17.19	18	33	309	567
Others	21.49	4	7	86	150
Total-daily	—	280	500	3,350	6,007
Total-month	—	8,400	15,000	100,509	180,220
Total-annual	—	102,200	182,500	1,222,859	2,192,679

Table 6: Recreational use value of the Iguacu National Park (R\$)

	Brazilians and Mercosul		Foreigners non-Mercosul		Total	R\$ / hectare /year ^(d)
Average annual visitors ^(a)	485.678		316.697		802.375	
Multiple destination model	Individual Visitor CS ^(b)	Use value ^(c)	Individual Visitor CS ^(b)	Use value ^(c)	—	477,15
	120,38	58.465.54 4	94,12	29.807.24 5	88.272.79 0	

(a) Average annual visitors between 1980 and 1998; (b) CS = Consumer Surplus; (c) Individual CS times average number of visitors per year; (d) Total recreational use value per year divided by total area of Iguacu Park.

(b) Adapted from Ortiz *et al.* (2000)

analysis of the expenses incurred by visitors of this place. It is a valuation method that generally uses questionnaires to a sample of visitors to a recreation site, collecting data such as the place of origin of visitors, their habits and costs associated with their trip. From these data, analysts can calculate travel costs and relate them (along with other factors) to a frequency of visits, so that a demand relation is established. This demand function for visits to a recreation site is then used to estimate the recreational use value of this site.

The Iguacu National Park has a significant annual flow of visitors, around 800,000 people, almost half of which originates from abroad. Tourism demand surveys in the city of Foz do

Iguacu indicated the existence of several attractions in the region, in addition to the Iguacu Park, which suggest that visitors did not always have the Park as the major reason for travelling to the region. Therefore, the application of the travel cost model to capture the use value of the Iguacu National Park must deal with the problem of multiple destinations. To this end, Ortiz *et al.* (2000) applied a specific model in which multiple destinations are treated and demand curves are estimated for each different combination of attractions. Based on these demand curves, the authors calculated the annual recreational use value of the Iguacu National Park, which was the sum of the welfare measures of different groups of

tourists, Brazilians and foreigners. The figures presented in Ortiz *et al.* (2000) were adjusted to year 2003 using the consumer price index (IGP-M). Table 6 shows the recreational use value of the Iguacu National Park.

Non-use value

The contingent valuation method consists of the use of sample surveys to identify, in monetary terms, the individual preferences in relation to goods which are not traded in markets. In environmental economic valuation, analysts ask respondents how they evaluate hypothetical situations involving a change in quantity or quality of an environmental resource. In this sense, hypothetical markets are created for the environmental asset - or scenarios involving changes in the resource - and respondents express their preferences through a willingness to pay (WTP) to obtain a change in quality or quantity of environmental resources. Non-use values can only be estimated using stated preference methods such as the contingent valuation method.

We are not aware of studies estimating the non-use value of the Iguacu National Park. However, Adams *et al.* (2008) estimated the non-use value of the Morro do Diabo State Park (PEMD) and also the remaining area of the Atlantic Forest in the Sao Paulo state, Brazil. This study showed the role of PEMD in preserving one of the last remaining areas of tropical semi deciduous forest in the interior of Sao Paulo; and that this importance is recognized not only by researchers and government officials directly involved in the management of protected areas, but also by the São Paulo population in general. Table 7 displays the total non-use value of the forest protected the in state of São Paulo.

With the results presented in Adams *et al.* (2008), and because it refers to the same type of biome area (interior Atlantic Rainforest), we can infer the order of magnitude of the non-use value of the Iguacu National Park. To this effect, we assumed that respondents' willingness to pay to protect an area of Atlantic Rainforest in Sao Paulo, though probably considerably less than that associated with protecting an equivalent area of that forest at Iguacu Park in the Parana State, the former can be used as a conservative benchmark for value transfer purposes.

Obviously, the environmental value of the National Park is not entirely lost in case the Colono Road is open. For example, the recreational use value is, in the short term at least, the same with or without the road in operation because visitors to the main attractions of the Park would continue their trips as usual. In the long term, however, it is possible that impacts are observed due to the environmental losses that would be caused by the Road being opened. Regarding the non-use value, only a share equivalent to the forest area impacted by the Road would be lost. In this regard, the potential impact of the Colono Road on the fauna and flora of the Iguacu National Park has been identified: "given a minimum range of 100 meters on each side of the road ... there will be a total range of about 200-220 meters where the "edge effect" may be significant, probably critical" (Milano *et al.*, 2000). Assuming this result, we estimated the forest area lost (in terms of its biodiversity) due to the opening of the Colono Road as ranging between 35,200 to 38,720 hectares⁹.

Since the annual value that the population of Sao Paulo would be willing to pay for a hectare of Atlantic forest is R\$ 279.49, we

⁹ 17.6 km long times 200-220 meters wide totals 3,520,000 – 3,872,000 m², or 35,200 – 38,720 hectares.

estimated the annual value of environmental degradation due to the opening of the Colono Road ranging between **R\$ 9,838,048 and 10,821,852**. It is emphasized that these estimates of the environmental degradation are underestimated for the following reasons:

- a) We do not consider potential losses of direct and indirect use values, and the option value of the Iguacu National Park;

Table 7: *Willingness to pay for conservation of the Atlantic Rainforest (R\$)*

	WTP (R\$)	Non-use value/month (R\$)	Non-use value/year (R\$)	R\$/hectare/year
Atlantic Rainforest	0.27	838,467	10,061,600	279.49

Adapted from Adams *et al.* (2008)

Table 8: *Cost-benefit of an eventual reopening of the Colono Road (R\$/year)*

	Minimum	Maximum
Benefits		
Tax revenue-ICMS	1.294.394	1.294.394
Road toll	1.222.859	2.192.679
Subtotal (a)	2.517.253	3.487.073
Cost		
Environmental degradation (b)	9.838.048	10.821.852
Benefit – cost (a – b)	-7.320.795	-7.334.780

- b) The non-use value corresponds to the population of Sao Paulo only. Residents of other regions of Brazil and the world could possibly have non-negative willingness to pay to preserve the Iguacu National Park.

study. The result confirms the initial statements of some interviewees during the fieldwork: the reopening of the Colono Road cannot be justified from an economic perspective.

4.1 COST-BENEFIT SUMMARY

Using the results presented in previous sections, we can get an idea of the magnitude of the economic costs and benefits directly involved in the reopening of the Colono Road. Table 8 summarises the results. The figures suggest that in the very short term, the social cost (underestimated) involved in the reopening of the Colono Road far exceeds the main private (overestimated) direct benefits identified in this

4. CONCLUSIONS

The controversy involving the Colono Road comprises an environmental, social, political and legal problem of difficult solution, which often generates heated and passionate discussion in the Iguacu National Park region. The various actors involved in the issue have different interests and approaches, which complicates the possibility of negotiated solutions between the various parties. The long period without a definitive solution to

the problem increased the lack of confidence among the various actors, further hindering the process for a final negotiated solution. The Colono Road is currently (2010) closed for traffic, and no other attempt to forcefully reopen it has happened since 2003.

The objectives of this study are twofold: (i) to identify the various interests for and against a possible reopening of the Colono Road; and (ii) to estimate an order of magnitude of potential economic impacts of reopening the Colono Road. To achieve the first objective, we undertook several interviews with stakeholders in the area of influence of the Iguacu Park for the identification of their main arguments. The second objective was developed using statistical data from secondary sources and official information obtained during the fieldwork. The results suggest that the reopening of the Colono Road cannot be justified from an economic perspective. At least in the short term, the social cost involved in reopening the Colono Road exceeds the major direct benefits identified in this study.

The quantitative results presented here should be used with caution, since there are several limitations in the methodology and data used in this study. The fact that we did not use a general equilibrium model limited our predictions about the effects of reopening the Colono Road on markets and demand and supply curves in the region. The use of secondary and aggregate data imposes further limitations. Finally, some simplifying assumptions were used to circumvent the lack of more accurate data. On the other hand, although the figures cannot be seen as accurate, they can be considered as consistent with economic theory and the usual techniques used in environmental economic studies.

Regarding the various interests and actors involved in the issue, a popular demand for the

reopening of the road could indeed be identified; especially in Serranópolis do Iguacu, Puerto Lupion - Capanema - and Medianeira. The most compelling reasons for this demand of the population relate to the cultural ties between the people on both sides of the road; and a historical heritage that includes several conflicts over land tenure and the questioning of the established political power, regardless of its political orientation. The neighbouring communities, particularly in Serranópolis do Iguacu and Capanema, are politicised, organised and easily mobilised when it comes to the Colono Road issue. Cultural, political and economic elites in these cities observed these cultural traits and history, making this popular demand - the reopening of the Colono Road - its political flag.

The observed lack of communication between IBAMA, the federal organism in charge of managing the Iguacu National Park, and the population of the surrounding cities, has worsened the problem, creating a certain antipathy of the population in regard to this organ and also in relation to the park itself. The leadership of the National Park at the time of this study, despite being imbued to reduce this gap through joint projects with the surrounding cities, faces a lack of credibility from all other parties. The credibility crisis was accentuated, the other way round, by the invasion of the Iguacu National Park promoted by "Friends of the Park" in October 2003.

The Iguacu National Park is regarded by part of the population in Serranópolis do Iguacu, as an enemy, an obstacle to economic development, the major source of all social problems. This view may have been fostered with electoral political interests, exacerbating popular dissatisfaction on the issues related to the Colono Road. It is necessary to develop a counter-

information strategy to change the image of the park, namely to highlight that the Iguacu Park can attract resources to the surrounding cities instead of being an obstacle to development. For example, individuals may not be aware of the amount of green-ICMS received by their communities because of the preserved area of the Park within their territories, which in the case of Serranópolis do Iguacu is quite significant. An alternative transport scheme to link families on both sides of the Park would help to defuse popular sentiment to reopen the Colono Road.

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ANNEX (ACRONYMS)

AIPOPEC – Associação de Integração Comunitária
Pró-Estrada do Colono (*Association for
Community Integration pro Colono Road*)

IBAMA – Instituto Brasileiro do Meio Ambiente e
dos Recursos Naturais Renováveis (*Brazilian
Institute for the Environment and Renewable
Natural Resources*)

IBGE – Instituto Brasileiro de Geografia e
Estatística (*Brazilian Institute of Geography and
Statistics*)

IPARDES – Instituto Paranaense de
Desenvolvimento Econômico e Social (*Parana
State Institute for Economic and Social
Development*)

IPEA – Instituto de Pesquisa Econômica Aplicada
(*Research Institute for Applied Economics*)

MMA – Ministério do Meio Ambiente (*Ministry for
the Environment*)

NGO – Non-governmental organization

WWF – World Wildlife Fund