#### **ON THE SUCCESSFUL IMPLEMENTATION OF MITIGATION MEASURES**

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#### Abstract

The discussion about the effectiveness of environmental impact assessment has shifted from the accuracy of impact prediction to our ability to effectively prevent significant environmental degradation and to fully implement cost-effective mitigation and other management measures. The actual impacts of the construction phase of a highway project in São Paulo State, Brazil, are reviewed by analyzing monitoring data. A detailed followup scheme and a tight internal control are the main reasons for the successful implementation of mitigation and other management measures required by the terms and conditions imposed on the project. A number of lessons learned may evolve into recommendations for similar projects: (i) a management system is a powerful tool to successfully carry on the implementation of mitigation and other management measures; (ii) checklists and audit protocols can be a practical solution to "translate" the terms and conditions of the environmental license, often stated in vague and inaccurate language, into enforceable, manageable and verifiable rules; (iii) external control is essential to guarantee the successful implementation of mitigation measures.

key-words: effectiveness, environmental impact assessment, follow-up, highways, impact audit

#### Introduction

The discussion on the effectiveness of environmental impact assessment (EIA) has shifted from the accuracy of impact prediction to our ability to effectively prevent significant environmental degradation and to fully implement cost-effective mitigation and other management measures. Recent papers have been emphasizing the need to focus on the "results" of the EIA process (Goodland and Mercier, 1999; Mercier, 2003) and to strengthen the post-approval, or follow-up phase (Morrison-Saunders et al., 2001).

The actual effects of the construction of Imigrantes highway, in São Paulo State, Brazil, which took place between August 1998 and December 2002, received particular attention in terms of monitoring and follow-up. This case provides a good opportunity to deepen discussion and analysis on achievements and remaining needs to ensure that the EIA process delivers "results" in terms of demonstrable environmental protection.

In this paper we review monitoring data and discuss the extent to which mitigation measures have been successfully implemented and the role that followup arrangements have played to ensure compliance with terms and conditions stated in the environmental license.

## 1. The project and the environmental monitoring plan

Imigrantes highway is a 70 km long, multilane road that links São Paulo capital city to the shoreline and the main port in South America, Santos. It crosses three different physiographic compartments: hilly highlands, a steep slope range dropping c. 800 m and coastal lowlands. São Paulo, in the highlands, and Santos, in the lowlands, are densely occupied industrial cities, whereas in the *Serra do Mar range* lying in between there are significant remnants of native Atlantic rainforest protected by a State Park. Moreover, lowlands feature a mangrove ecosystem of high ecological relevance.

An older road had been in operation since the 1950s, but quickly became saturated, prompting the Roads Department to plan the Imigrantes scheme. The original project dates back to the 1970s, when two separate highways have been planned to cross the *Serra do Mar* range (Figure 1). Due to the high costs of construction in this mountainous zone, only one expressway had been built in the 1970s, the ascending roadway. The project for the second roadway has been postponed until the 1990s, when a new transportation policy was adopted by the State government, calling for tendering highways construction and operation to private bids. Under this model, a private company would manage tolled roads for twenty years, provided that investments in expansion and maintenance were made according to an agreed plan and schedule. Therefore, Ecovias dos Imigrantes S.A., a special purpose private company successfully obtained a concession and started reviewing and updating the project for the second highway.

The revised project for this 23-km long stretch included about 8km of tunnels, 4km in viaducts and 11 km of cut and fill. An existing service road has been restored and used during construction to convey materials, equipment and personnel.

Following the environmental impact assessment (EIA) process, an environmental license has been granted to the construction of the new roadway, but a strict monitoring and follow-up plan has been included in the terms and conditions imposed on the project owner. Gallardo and Sánchez (in press) provide a detailed description of the EIA process and its outcomes, and point that this follow-up arrangement is unusual for most projects submitted to the EIA process in São Paulo State. The main reasons that led environmental authorities to impose severe monitoring and follow-up conditions include:

(i) the vulnerability of affected ecosystems – intense rainfall over the steep slopes in the range triggers landslides and other mass movements which can have severe economic and ecological consequences;

(ii) legal restrictions for construction in protected areas;

(iii) the high visibility of the project, since the highway is used by millions of people all year round;

(iv) previous experience with highly unsatisfactory environmental compliance by contractors and by the State Roads Department;

(v) the fact that the project owner and manager is a private company.

Consolidated data and an accompanying analytical report have been filed with the State Environment Department every six-month. A final report consolidates data for the whole construction period (JGP, 2003). Another report (JGP, 2002) describes the implementation of mitigation and compensation measures required by the terms and conditions of the environmental licenses.

## 2. Arrangements for environmental follow-up

Monitoring requirements have been established in the environmental license, based upon the environmental impact statement and complementary reports (Gallardo and Sánchez, 2004) Data have been collected by a consultancy (JGP). The consultant designated a team of six professionals (one full-time) plus auxiliary people for supervision and monitoring, The consultancy maintained a system of environmental records, aimed at establishing a historical register of retrievable documents and data and producing "documental proofs that all mitigation or preventative measures" had been adequately implemented (JGP, 2003). A manual of environmental monitoring (JGP, 1999) provided a detailed description of procedures and responsibilities. This system has been operational beginning in April 1999, when heavy works commenced.

Supervision and auditing activities were part of the consultancy's tasks, and included regular visual inspections of construction yards in previously selected control points to check, among others, waste management, oil containment, used oil storage and management, soil excavation and final disposal, state of signs transmitting environmental messages to workers, evidence of erosion processes, evidences of river siltation, practices of dust suppression in rock crushing and aggregate storage and transportation. Detailed inspection forms had to be filled in and filed. A total of 52 items had to be checked in the inspections of works in progress, whereas 37 items needed to be verified in the area of ancillary installations (rock crushing and aggregate storage, workshops, canteens, sewage treatment installations etc.). Furthermore, specific forms and guidance have been prepared for visual inspections along creeks and in areas of cut and fill earthmoving.

These forms have been organized like checklists or audit protocols. They incorporated both good environmental practices in heavy construction and the requirements of the environmental license. Hence, they were a practical solution to "translate" the terms and conditions of the license, often stated in "vague and inaccurate language" (Dias and Sánchez, 2001), into enforceable, manageable and verifiable rules. In fact, several gaps have been identified by Dias and Sánchez (2001) that hinder proper implementation of mitigation and other management measures arising from the EIA process in São Paulo. Bridging the gaps are considered crucial to achieve desired levels of environmental protection.

For every nonconformity or observation, a correspondent form was filled in, sent to the responsible sector with recommendations for correction and then filed. This supervision and auditing model has close similarities with an environmental management system. In fact, Ecovias dos Imigrantes S.A. obtained an ISO 14001 certificate for the operation of its road system. Although Ecovias did not seek certification of the construction activities, the contractor had to comply not only with terms and conditions of the environmental license, but also with requirements of the project owner.

Besides supervision and monitoring performed by JGP, the State Department of the Environment commissioned the services of the Institute of Technological Research (IPT), a government research body, to oversee the impacts on the physical environment. A team of four part-time professionals performed weekly inspections. The team checked the actual impacts and evaluated the effectiveness of mitigation and preventative measures. In case of non-conformity, corrective actions were recommended and reported to the Environment Department. Two consolidated reports have been issued by IPT (2002a, 2002b).

Moreover, the Parks Service *(Instituto Florestal)* periodically oversaw the construction site and reviewed ongoing reports. In addition, the Parks service also followed up an environmental compensation program, by which native trees had to be planted in designated sectors within the Park, among other measures.

Finally, every month, the Environmental Impact Assessment Branch (DAIA) of the Environment Department oversaw construction works and coordinated

periodical work meetings to evaluate results and performance. DAIA received reports from Ecovias every six months in addition to monthly reports from IPT.

# 3. Monitoring Methods

## Physical environment

Monitoring impacts on the physical environment has been conducted through field inspections to directly observe any significant alteration, including:

- engineering practices such as slope protection and existing and efficiency of sediment traps;
- evidence of erosional or instability processes such as gullies, fissures, possible obstruction of natural drainage, or presence of rock blocks in creeks;
- volume and dimension of landslides.

Location of critical inspection points is shown in Figure 1.

As routine inspection for sedimentation, 13 control points situated in creeks were visually checked every week; any evidence of siltation was observed. In addition, in three small flat sectors situated downstream of major earthworks, a set of vertical rules has been installed in order to measure the height of sediments.

# Water quality

Water samples have been collected in 27 control points (Figure 1), 10 upstream and 17 downstream. most of time, however, only 18 points (12 downstream and 6 upstream) have been monitored, due to completion of works in parts of the affected area. The environmental license determined that only pH, water color and turbidity should be measured. Specific water quality limits have been established by the environmental license: limits for pH (6,5 < pH < 7,5) are more stringent than regulatory standards, but limits for color (< 200 mg Pt/L) and turbidity (< 150 NTU) are more permissible than general regulatory standards. This is probably due to the natural dynamics of the *Serra do Mar* environment, featuring high sediment yields after heavy rains.

# Fauna

Mammals and reptiles have been monitored through field direct observation and indirect detection methods (tracks, feces). Every running over due to construction works (usually occurring in the auxiliary service road) has been registered, after identification of the affected species. Bird surveys have been included in the final year. Observation was carried out along the work site and in the affected watersheds, totaling 493 hours.

#### Noise

Noise monitoring was carried out in 14 points (Figure 1) in three campaigns, using standard equipment and methods. All these points are situated in the lowlands, in the vicinity of urban areas and subject to the influence of existing road network. Results were provided in equivalent sound pressure level ( $L_{eq}$ ).

## Vegetation loss

Actual surface of vegetation cut down has been measured through topographical survey. Inspections checked if any non-authorized or excessive cutdown had been done and documented reports were prepared and filed. Any nonconformity was registered and communicated to both the contractor and the project owner.

# 4. Monitoring Results and Discussion

This section summarizes monitoring data and discusses compliance with terms and conditions of environmental license.

## Physical environment

The main observed impacts have been: (i) vegetation covered by excavated soil; (ii) river channel obstruction by rolling rock blocks; (iii) development of gullies in earthfill works; (iv) localized landslides; (v) river siltation. The most significant observed impacts have been river channel obstruction affecting creeks in three points downhill from viaduct pillar construction and one point below an earthfill. The most affected points have been around viaduct pillars, along zones of earthmoving (cuts and fills), and near tunnel portals.

River siltation has been significant in one location only, from where sediments have been removed. Landslides mobilized only very small amounts of material (dozens of cubic meters). The only registered gullies were shallow. Sediment traps retained eroded soils and prevented it to reach creeks. The best indicator that adequate measures have been taken to prevent and control erosion and other processes is the low level of river siltation and the need to remove sediments only once.

## Water quality

Data for water quality showed that most of time quality standards have been met, except for pH. Out of a total of 1220 samples, 475 (38,9%) exceeded quality standards for pH, 17 (1,39%) exceeded quality standards for turbidity, and 27 (2,21%) exceeded quality standards for water color. An example is provided by results obtained in two points located upstream (P-05) and downstream (P-06) of road works, in the vicinity of water intake to a public supply treatment plant. (Figure 2).

A significant water pollution problem was detected in the initial phases of tunnel excavation. Water draining from tunneling featured high turbidity and suspended solids concentration and reached creeks and rio Cubatão (Figure 1), the major local river. A sudden change in water color has been observed by the downstream local population. This prompted the State pollution control agency (Cetesb, a branch of the Environment Department) to forbid any further discharge. Four wastewater treatment plants have then been built to neutralize alkaline drainage and to precipitate solids. Even so, one creek showed extensive carbonate precipitation over boulders and creek floor and had to be later manually cleaned up.

#### Vegetation loss

Reports on vegetation loss indicate that 40 hectares of natural vegetation have been cut down. This amount is quite low if compared to vegetation loss due to the construction of the ascending roadway in the 1970s, which reached 1600 ha for a similar road. Such a reduction is due to three major factors: (i) the new project represented 8.2 km of tunnels against 3.9km in the ascending roadway; (ii) using the existing service road and degraded areas remaining from the 1970s works for ancillary installations: and (iii) careful handling of viaduct construction. However, supervision recognized eight events of nonconformity related to either suppression prior to receiving specific authorization or to undue cutting.

#### Fauna

Thirty-four mammal and eighteen reptile species have been registered during monitoring, comprising 4 mammals included in the State list of endangered species. Bird surveys identified 159 species, out of which 10 are in the State list of endangered species. This is significantly more than the baseline survey made during preparation of the environmental impact statement, that had identified only 38 birds, 12 mammals and 9 reptiles. Nevertheless, no active survey method has been used to monitor animals during this construction phase. Running-overs involved mostly two species of rodents (*Didelphis spp.*) and one serpent, although species identification is not always possible after a running-over. A total of 93 individuals died for this reason. On the other hand, 111 individuals (mammals and reptiles) have been safely captured and transported to other parts of the Park.

Impacts of construction over fauna have been minor. No running-over or other incident relative to an endangered species has been registered and animals involved in running-overs are not rare. A full appraisal of impacts was not an objective for this project.

#### Noise

Sound pressure levels ranged from 54 to 80 dB(A) in the first campaign (June 2001), from 55 to 78 dB(A) in the second campaign (December 2001) and from 55 to 79 dB(A) in the third campaign (June 2002). The worst point is #2, situated right besides an upwards lane of the 1950 road, subject to intense truck passage, whereas point #4, situated beside a flat extent of another road, showed the lower figures (Figure 1).

The main purpose of noise monitoring is to establish a baseline for comparison with the situation during operation of the new project, which is expected to increase traffic volume in other roads. Results showed that noise levels are already very high.

## 5. Compliance and performance

Current practice of EIA in São Paulo seldom involves reporting on environmental performance. Although monitoring data and reports are sent to environmental authorities, reports often lack analytical interpretation or an explanation about the reasons that led to such results (Dias and Sánchez, 2000). Hence, the wealthy of good and bad experiences is not transformed into any kind of institutional learning; records of good practice remain mostly in the memories of individuals and are not systematically incorporated into new requirements or recommendations. In this context, Imigrantes construction may prove to be an exceptional source of inspiration for detailed analysis.

Objective evidence of environmental performance, and especially of legal compliance, is provided by actual monitoring results. Monitoring data reviewed above suggests that, given difficult work conditions and the sensitivity of the affected environment, the contractor achieved a satisfactory level of compliance. On the other hand, explanation for successful implementation does not follow automatically from the follow-up arrangements put in place. Internal organization and internal arrangements for management and control are essential factors.

Thus, Imigrantes successful implementation of mitigation measures should be interpreted under the perspective of the management system adopted. Measuring and interpreting environmental performance is the subject of international standard ISO 14031:1999 (ISO, 1999), which provides for two types of environmental indicators:

- (i) environmental condition indicators;
- (ii) environmental performance indicators, out of which there are two subclasses: management performance indicators ("that provide information about management efforts to influence the environmental performance of the organization's operations") and operational performance indicators ("that provide information about the environmental performance of the organization's operations")

This last category can be discussed by analyzing data stored in the system of environmental records. Although a full analysis of the performance of the management system is beyond the scope of this paper, looking at a few data can help in explaining results achieved. Table1 summarizes the number of forms filled in for each of the following categories (terminology in accordance with the Manual of Environmental Monitoring, JGP, 1999):

- (i) number of nonconformities registered in the system of environmental records: 69
- (ii) number of recommendations of corrective action issued: 1016
- (iii) number of incidents and accidents (called occurrence register, documented by photos): 95
- (iv) documentation of corrective action: 1002
- (v) documentation of preventative action: 1374

No regular pattern seems to emerge from these data, except that in the first period there is a higher number of recommended corrective actions, what are probably due to the concentration of heavy works in this initial phase. Later decrease in this indicator could also be due to a more preventative approach adopted by the contractor after initial months.

Finally, all this paperwork shows evidence of compliance and corrective action, thus contributing to the declared goal of producing "documental proofs that all mitigation or preventative measures" had been adequately enforced.

Internal reasons certainly played a significant role in explaining the successful implementation of management measures in this project. Nevertheless, internal controls are driven by external forces, which are the ultimate reason for which an organization seeks compliance.

Reasons for effective EIA systems have been examined by a number of authors and international teams. Criteria for effectiveness can be very broad. Sadler (1996) provides three main distinctions in terms of yardsticks for evaluation:

- *"procedural:* does the EIA process conforms to established provisions and principles?
- *"substantive:* does the EIA process achieves (...) well informed decision-making and result in environmental protection?
- *"transactive:* does the EIA process deliver these outcome at least cost in the minimum time possible?"

One single case study permits only to draw conclusions on the substantive dimension of EIA effectiveness. As available data above discussed indicate that the Imigrantes construction phase has featured adequate compliance and has been developed in accordance with terms and conditions imposed on the project, which lessons could be learned from this experience? Which reasons contributed to its success? Could the follow-up arrangements be adapted and used in other projects?

Proper functioning of control mechanisms has been proposed as an explanation for successful EIA (Ortolano, 1985; Ortolano et al., 1987). Most legislation and regulations on EIA have built-in control mechanisms (Prieur, 1984) and Brazilian regulations are no exception. The Imigrantes case shows a remarkable (and probably unusual) combination of effective control.

Administrative or procedural control has been tightly exerted during both review and approval and implementation (post-approval) phases. Not only has the project been modified and adapted to avoid or reduce significant impacts, but also extensive mitigation and compensation measures have been agreed upon, as reviewed by Gallardo and Sánchez (2004). After project approval, inspecting and overseeing construction works by IPT, the Parks Service and other government branches, as well as reviewing monitoring reports, were part of this control.

Judicial control played an alert and a substantive role during construction. In fact, when water pollution has been detected and communicated, the public attorney immediately acted to obtain a judicial order that stopped all construction activities for one day. Arguably, this is the toughest sanction a construction company may have, since it has to meet strict contract schedules and must pay workers and contractors. In only one day a technical solution has been agreed upon, emergency measures have been implemented, and a formal agreement has been signed up by the litigant parties, resulting in the suspension of the embargo.

Public control played a role as well. NGOs have been active in the preapproval discussions, but did not put pressure on the construction phase. However, citizens were certainly aware of the potential harmful impacts and both the project owner and the contractor knew that any visible impact would receive immediate media attention. Furthermore, it should be noticed that it was one downstream dweller who warned authorities that surface waters showed visible signs of alteration, thus prompting both administrative and judicial action.

Instrumental control, defined by Ortolano et al. (1987) as supervision of lending agencies over required tasks, also played a role in this project, because the project owner obtained a loan from the Inter-American Development Bank. Bank procedures, especially audits imposed another check on construction activities.

All these control mechanisms played a role in the process and can be credited to have created an environment that pushed for effective enforcement and compliance.

# 7. Conclusions

Building a highway through a sensitive environment is always both an engineering and an organizational challenge. Imigrantes project provides a positive example of best practices in project design and implementation that led to successful environmental compliance. Lessons learned through the analysis of this case provide for a number of conclusions that possibly can be generalized to similar projects in different jurisdictions:

- successful impact control is due to a carefully designed and implemented monitoring and follow-up scheme;
- □ a management system is a powerful tool to successfully carry on the implementation of mitigation and other management measures;
- checklists and audit protocols can be a practical solution to "translate" the terms and conditions of the environmental license, often stated in vague and inaccurate language, into enforceable, manageable and verifiable rules;
- complex projects built in sensitive environments need a robust follow-up scheme to detect and correct any unpredicted impact;
- external control is essential to guarantee the successful implementation of mitigation measures.

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# Table 1

# Number of supervision and auditing documents emitted in accordance with the system of environmental records

Reports	non conformities	recommendations of corrective measures	incidents and accidents	documentation of corrective actions	documentation of preventative actions
1 <sup>st</sup> Report April/99-April/00	22	336	12	125	153
2 <sup>nd</sup> Report May/00 – Dec/00	10	204	9	205	247
3 <sup>rd</sup> Report Jan/01 – Jun/01	4	128	7	177	144
4 <sup>th</sup> Report Jul/01 – Dec/01	7	89	10	152	263
5 <sup>th</sup> Report Jan/02 – Jun/02	16	138	27	179	319
6 <sup>th</sup> Report Jul/02 – Feb/03	10	121	30	164	248
Total	69	1016	95	1002	1374

source: JGP, 2003)







