

# THE CONNECTION BETWEEN THE METROPOLIS OF SÃO PAULO AND SANTOS PORT

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## ABSTRACT

The *Imigrantes* Highway occupies a strategic place in the economy of São Paulo, connecting Brazil with the Asian, European and American markets.

The objective of this paper is to analyse the interventions that occurred as a result of the construction of the Highway, emphasising the technological and environmental issues. The *Imigrantes* descending lane was inaugurated in 2002. It runs through a forest area, called the State Park of *Serra do Mar*. The road is 21 km in length, with three tunnels and nine viaducts. The technology applied allowed 40 times less deforestation of the Atlantic Forest, in contrast to the first lane which cleared an area of 1 600 ha. For the construction of the descending lane, the Environmental Impact Assessment (EIA) and the Environmental Impact Statement (EIS) that were done led to ISO 14001 Environmental Certification being obtained from the Brazilian Association of Technical Norms. The awards gained by the *Imigrantes* Highway prove that suitable technology can be applied to favour sustainable development.

## 1. INTRODUCTION

The development of any nation, no matter how large or small its territory, requires the provision of proper and efficient means of transportation which integrates the different regions and encourages their socio-economic growth.

The increase of the infrastructure system capacity in Brazil is aimed primarily at supporting the flow of production, at increasing the options for access to the country and at improving tourism.

The favourable prospects for the expansion of the economy create expectations of a greater need for infrastructure that will enable goods to be transported and vehicles to be moved in and out of the country.

In this context, the Metropolitan Region of São Paulo has a crucial role to play in the management of the country's transport because important national roads run into it, including the Anchieta-Imigrantes System, which is the link between the metropolitan region, the Port of Santos, the petrochemical area of Cubatão, the plants of the plateau and the Baixada Santista (composed of the cities of Bertioga, Cubatão, Guarujá, Itanhaém, Mongaguá, Peruíbe, Great Beach, Santos and São Vicente). The Anchieta-Imigrantes System is today 206 km in length and is the main corridor for exports to Latin America. It is formed by the following highways: Anchieta, Imigrantes (including the

recently inaugurated descending lane), Manoel Padre da Nóbrega, Cônego Domênico Rangoni and two interconnecting roads between the Anchieta and the Imigrantes: one in the plateau and another one in the Baixada. The system is of vital importance to the Brazilian economy because of the heavy traffic it carries, reaching 30 million vehicles per year or even more.

Against the above background, a multi-disciplinary project, which included the construction of the second lane of the Imigrantes Highway, connecting the sea (Baixada Santista area) to the plateau, was devised. This lane, inaugurated on 17 December 2002, is 20,3 km in length (and includes tunnels and viaducts) surmounting a difference in elevation of nearly 730 m. The construction of the Highway, a project with international implications, has been remarkable due to the adoption of stringent criteria regarding the environmental impacts and the use of advanced technology that minimised the impact on the natural surroundings. In operation, it helps to alleviate the complex traffic on the old Highway (the ascending lane), which carried an excessive number of cars and trucks.

According to ECOVIAS (2005), it will probably increase the traffic capacity from 8 000 to 14 000 vehicles per hour and this will stimulate the development of the Baixada Santista.

The Port of Santos was opened on 2 February 1892. Today it moves up to 38 million tons per year and is the largest port in the Southern Hemisphere. It has the largest container terminal in Latin America, with a capacity of 550 000 m<sup>2</sup>. It also includes 12 km of wharf, with specialised terminals for grain, fertilisers, bulk liquids and containers, and two railway lines with a total length of 200 km. Its geographic position is favourable to the development of intermodal transport (road-marine), guaranteeing an economical and fast alternative for many countries.

The Port is currently planning ambitious modernisation to make it more flexible, better equipped and more competitive. More than 120 companies operate in the Port, dealing with 30% of the Brazilian trade balance and permitting rates of development of up to 10% per year (Instituto de Engenharia de Sao Paulo, 2004).

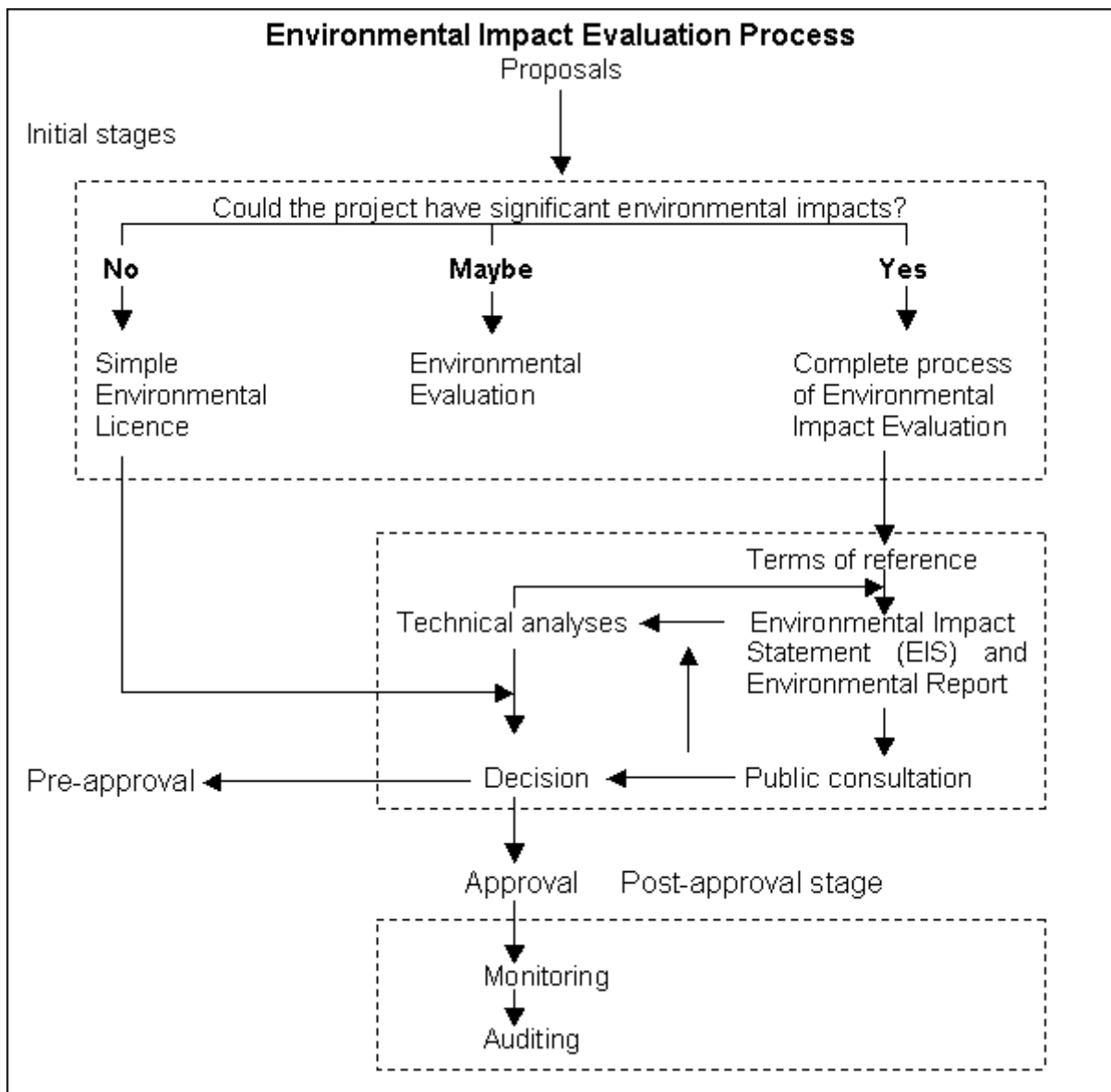
The objective of this paper is to analyse the interventions that occurred as a result of the construction of the Highway, emphasising the technological and environmental issues.

## **2. HISTORY OF THE HIGHWAY**

At the end of 1960s, studies were initiated into the viability of constructing three lanes linking the plateau to the Baixada Santista (the coastal plain): one ascending, one descending and one reversible. Due to economic reasons, only the ascending lane, passing through the plateau, Serra do Mar and the Baixada Santista, the infrastructure for the other lanes, at both ends, and a service road for the transport of equipment and material were built. Ten years later, in 1988, the basic project of the second lane (descending) was constructed, which included several measures for environmental preservation, such as the protection of the river heads, streams and rivers of the region, lane drainage and the protection of the hillsides against erosion. However, although the construction of the second lane (descending lane) was started in 1998, it needed to be re-evaluated in order to use more modern construction techniques and alternative designs that took the new local conditions into consideration. Owing to the difficulties in obtaining an environmental licence – necessary for construction in forest areas – the environmental aspects had a great influence on the details of the projects involved in the construction of the descending lane.

### 3. THE ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AND ENVIRONMENTAL IMPACT STATEMENT (EIS) FOR HIGHWAY PROJECTS

The Environmental Impact Assessment (EIA) was introduced into Brazil in 1981. It is an important tool for evaluating the environment during all the phases of road construction. The EIA process can be organised into steps that can ensure the viability of a project and its subsequent approval. Its function is to examine the consequences of human actions, making use of certain techniques for evaluating the likely magnitude of the damage and the efficiency of the mitigation measures in real time. Thus, a project plan must encompass the following steps: screening; target definition, project elaboration and study of alternatives, presentation and analysis of the Environmental Impact Statement (EIS), including public participation, decision-making, monitoring and audits. The process stages are presented in Figure 1:



**Figure 1. Environmental impact evaluation process (Gallardo, 2004).**

The Environmental Impact Statement (EIS) assists in minimising the damage caused to nature, mainly in major works such as the construction of highways. It is of great importance in the formulation of the project to select the alternative that offers the greatest

harmony with the environment. The technical, economic and environmental aspects must be balanced during the project definition.

The construction of roads represents a period of great interference with nature because this phase involves the establishment of the work camps, drainage services, earth moving, borrow areas, the construction of tunnels, viaducts and bridges, etc. In general, the main impacts caused by such construction are associated with the water resources, the flora, the fauna, the soil, the communities nearby, the economy of the region, the historic and cultural heritage and the health of the population. The main impacts foreseen in the case of the descending lane of the Imigrantes Highway were: erosion, alteration of the quality of the water and soil, clearing of the forest, blockage of valley roads and alteration of the slope geometry (Gallardo, 2004).

#### **4. MEASURES TAKEN DURING THE CONSTRUCTION OF THE DESCENDING LANE (SECOND LANE)**

The great challenge of this construction is the fact that the Highway crosses three sites of great environmental concern: an area in which the water supply sources need to be protected for the Metropolitan Area of São Paulo, the State Park of Serra do Mar and the region of estuaries and mangroves of the Baixada Santista. This concern about environmental preservation arises from the ecological awareness that society has built up over recent decades.

This awareness can be noticed even in the history of the construction of the Highway. According to Oliveira (2002), during the construction of the first lane, the natural environment was severely damaged due to disorganised processes of destruction and occupation. With the second lane, a set of measures made it possible to decrease this impact considerably.

With the boring of the tunnels, for example, care was taken that the water generated during this work did not pollute the streams in the region. For this purpose, four water treatment plants with a capacity to treat up to 700 000 l/h were constructed. In this way the water stemming from excavations, the water contaminated with powdered rock during boring and also the water mixed with powdered concrete was returned to nature without impurities.

With regard to the water from the washing of the concrete mixers, it was possible to install a system for the re-utilisation of this water in the concrete plant itself, which meant that the water had no contact with the environment.

The work camps are another interesting aspect: they were strictly settled on the available sites along the service road in order ensure no interference with the forest vegetation.

With regard to the waste generated by the workers, a sewage treatment plant was installed that achieved an efficiency rate of 95% in removing the polluting load. In addition, all the garbage from the remainders of meals was put into cool chambers until collected by a special vehicle. It is worth highlighting that the number of workers hired in the second phase was much smaller than in the first phase, thus reducing the impact of their permanence in the region (4 500 jobs were created during the construction of the second lane).

A programme for the protection of wild animals involved collecting these animals and transferring them to environmental organisations or to other places in the forest.

Interference with the native forest was minimised by the use of advanced construction technologies. The viaducts down the sides of the Serra do Mar were redesigned to increase the distance between their pillars. The pillars were constructed 90 m apart, instead of the 45 m distance specified in the original design. The equipment and materials were transported by cranes to the place where the foundations and pillars would be built, without affecting the surrounding forest. Three tunnels were planned, totalling 8.23 km in length. In this way, it was possible to decrease the interference in the forest to seven points only (three entries, three exits and a “window” used to accelerate the construction and for the emergency exit). All these measures helped to reduce the necessity for deforestation 40-fold compared with the previous construction.

The new lane of the Imigrantes Highway has a rigid concrete pavement, which is more resistant to wearing than the flexible asphalt pavement commonly used in Brazil. This reduces the need for maintenance and reconstruction work.

## 5. THE IMPACT OF THE HIGHWAY IN THE BAIXADA SANTISTA

According to ECOVIAS (2005), the opening of the new Imigrantes lane could cause an increase in traffic flow of up to 70%, which in turn could cause an increase in the number of people living in the area and an increase in tourism. The mayors of the cities in Baixada Santista all expressed their concern regarding this matter. As mentioned before, the easy movement of traffic between the plateau and the coast is favourable to the economic development of the region. However, the cities must have detailed plans, complying with specific norms, for territorial occupation and environmental preservation.

According to DERSA (1998c), for the region to absorb the expected increase in people and goods transportation, it will be necessary to update and make effective the Directive Plan for the Development of the Cities, mainly regarding the following aspects:

- urban infrastructure
- tourism development
- industrial activity development
- legislation on environmental preservation.

Two years after the inauguration of the lane, the areas deforested because of the tunnels (Figure 2) and also at the base of the viaducts had been restored as requested in the Environmental Impact Statement.



**Figure 2. Replacement of the vegetation.**

There was less need to replace the vegetation after the construction of the second lane compared with the first one, due to the care taken during the road construction. According to DERSA (1998a), about 80 000 trees were needed to reforest an area of 2 000 000 m<sup>2</sup> after the ascending lane was built and only 30 000 trees (maximum) had to be replaced in the second case. The efforts to minimise the deposition of soil on the edge of the road reduced the silting up of valleys and the erosion of the areas without vegetation (DERSA, 1998b).

Concerning the fauna and flora of the Baixada Santista, special attention was given to the mangroves of the region. These ecosystems are restricted to the tropical and subtropical coasts, develop in the zone between tides and are generally situated at the mouths of the rivers. Aquatic birds are found there due to the presence of banks of silt, which are rich in crustaceans and clams. These ecosystems are vulnerable to the effect of economic development and of the disordered growth of human populations. They are also important for the protection they afford to the land areas against storms and the erosive action of the tides.

Due to urban occupation over the years, the mangroves of the Baixada Santista are being continuously degraded and have lost many of their features. The city of Cubatão, for example, originally had 29 km<sup>2</sup> of mangroves, but now only 19,2 km<sup>2</sup> remain, of which 7 km<sup>2</sup> are partially preserved and 11,5 km<sup>2</sup> are degraded, including areas where the vegetation is no longer characteristically mangrove.

Despite the fact that the descending lane was constructed on a pre-existing earth embankment, diminishing interference with the mangroves, there has been damage caused by the actions of man, as can be seen from the presence of litter and other types of odd materials (Figures 3 and 4).



**Figure 3. Pollution in the mangroves.**



**Figure 4. Mangrove area.**

Activities generated by increasing tourism, such as the sale of crabs (Figure 5), are common in the Baixada Santista area. This demonstrates the lack of environmental concern and man's aggression towards the mangroves. The damage could reach even higher levels or could become irreparable due to the presence of people without adequate jobs and housing. The high risk of accidents and running across the road related to the presence of vendors along the side of the Highway also poses a problem.

The need for the construction of more pedestrian walkways at the end of the road is also noted, because a large part of its length is completely urbanised (Figures 6, 7 and 8).



**Figure 5. A man selling crabs.**



**Figure 6. The urbanised part of the descending lane.**



**Figure 7. First pedestrian walkway in the urbanised part of the highway.**



**Figure 8. Second pedestrian walkway in the urbanised part of the highway.**

Concerning urban infrastructure, it can be said that the cities are not properly prepared to receive this additional population. The housing shortage leads the low-income population settling in inadequate areas, without sanitation, such as on the hillsides and in the mangroves (Figures 9, 10 and 11).



**Figure 9. Urban occupation near the highway.**



**Figure 10. Urban occupation in the forest.**



**Figure 11. Urban occupation near the river.**

This situation was observed during the construction of the first lane and to date proper care has not been taken to curtail it. Thus, the deficiency in the distribution of treated water and in the sewage system can cause pollution in the water sources and on the beaches. The group of houses for the low-income population who live in the region – a suggestion of the Environmental Impact Statement (EIS) – has still not been built.

The population increases in the cities of the Baixada Santista over the last decade are shown in Table 1.

**Table 1. Population of the cities of the Baixada Santista (1991, 2000 and 2004).**

City	Population		
	1991	2000(**)	2004(***)
Bertioga	(*)	30.039	39.565
Cubatão	91.136	108.309	117.120
Guarujá	210.207	264.812	292.828
Itanhaém	46.074	71.995	85.294
Mongaguá	19.026	35.098	43.344
Peruíbe	32.773	51.451	61.034
Praia Grande	123.492	193.582	229.542
Santos	429.923(*)	417.983	418.255
São Vicente	268.618	303.551	321.474

(\*) Bertioga used to be a district of Santos

(\*\*) Population living in the city on 1 September (2000)

(\*\*\*) Population living in the city on 1 September (2004)

Source: Santos Municipality (2005)

## 6. CONCLUSIONS

With the advances in technology, major improvements were made in the manner in which the descending lane of the Imigrantes Highway was constructed. The environmental impact was vastly reduced and the State Park was left almost unblemished. This is a prime example of how proper planning and control can minimise the impact of engineering projects.



## 7. REFERENCES

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