

## Escoffier Diagram applied on Santos Estuary inlet

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### Abstract

Santos Estuary has faced several anthropogenic interventions during the last two decades. The main changes were deepening dredging and construction of terminals in Port of Santos. Thus, through Escoffier Diagram, which assess the inlet cross-sectional stability, has been noticed a variation on the stability of Santos Estuary inlet (Figure 1) between 2006 and 2014.

### Key words:

Santos, Estuary, Tidal Inlet, Escoffier Diagram

### Introduction

Port of Santos is an estuarine port located at the southeast coast from the state of São Paulo, which has been receiving investments for the deepening dredging and expansion of its terminals. This study defines the closure curve for Santos Estuary inlet, using Escoffier Diagram, for the years of 2006 and 2014, and determinate the equilibrium areas of the inlet gorge (Figure 1).

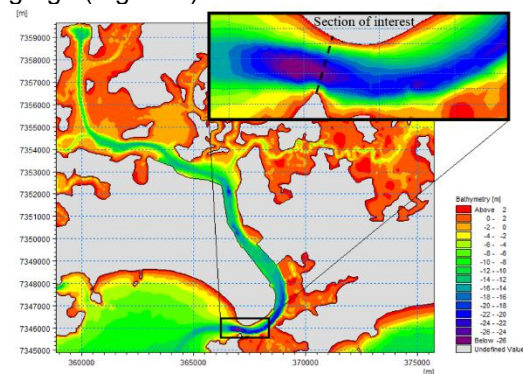


Figure 1. Section of Interest on the gorge of Santos Estuary Inlet<sup>1</sup>.

### Results and Discussion

Through the resulting expression for the amplitude of the tidal velocity in the channel<sup>2</sup>, the closure curve and the equilibrium velocity expressions were obtained. Then, considering some characteristics such as the inlet cross-sectional area, the estuary basin area, tidal prism, and the inlet channel length (Table 1) the Escoffier Diagram was drawn for the years of 2006 and 2014 (Figures 1 and 2).

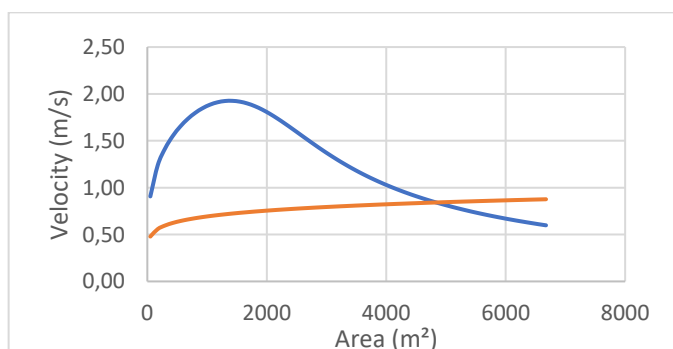


Figure 2. Escoffier Diagram for the year of 2006  
Blue: Closure curve. Red: Equilibrium velocity

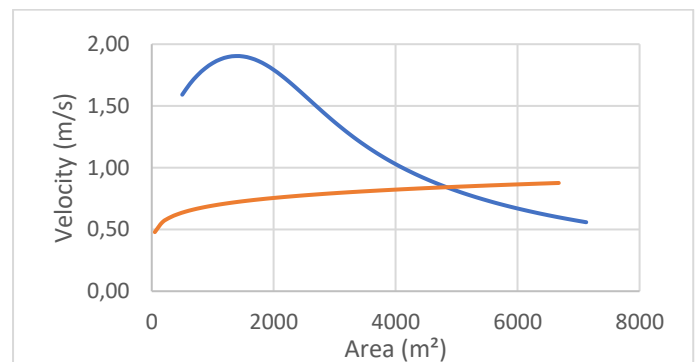


Figure 3. Escoffier Diagram for the year of 2014  
Blue: Closure curve. Red: Equilibrium velocity

Table 1. Inlet characteristics

Year	Tidal prism (m³)	Estuary basin area (m²)
2006	55.1X10 <sup>6</sup>	2,34X10 <sup>7</sup>
2014	53.6X10 <sup>6</sup>	2,30X10 <sup>7</sup>

Table 2. Area comparatives

Year	Real area (m²)	Equilibrium area (m²)
2006	6.105	4.448
2014	5.769	4.183

### Conclusions

According to Table 2, both years analyzed presented smaller equilibrium area when compared to the real area. Thus, the region of Santos Estuary inlet may be under siltation. This result is confirmed by the siltation estimates in Port of Santos inlet between the years of 2010 and 2013<sup>3</sup>. Also, according to the results, the equilibrium area has decreased between the years of 2006 and 2014. This was expected considering that the estuary basin area decreased. The only difference considered in this study was land reclamation due to the construction of port terminals.

<sup>1</sup>CORRÊA, T.; GIRELI, T.; PINHEIRO, V. Chapter 11: Land Reclamation Effects on Santos Estuary inlet. In: Climate Change in Santos Brazil: Projections, Impacts and Adaptation Options. Eds: Nunes, LH; Marengo, JA; Greco, R. In press.

<sup>2</sup>VAN DE KREEKE, J. Equilibrium and cross-sectional stability of tidal inlets: application to the Frisian Inlet before and after basin reduction. Coastal Engineering, v. 51, n. 5-6, p. 337 - 350, 2004.

<sup>3</sup>CARVALHO, V. de O. Estimativa da Taxa de Assoreamento do Canal de Navegação do Porto de Santos. Rio de Janeiro, 2016.