River Transportation in Brazil

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Key Words: river transportation, Tietê-Paraná, inland waterways, multi-modal transportation

1. INTRODUCTION
Brazil is a continental country benefited by water resources. There are seven main hydrological basins that include Amazon river, which is famous for its length and water flow, and other less well known but of great importance such as São Francisco and Paraná rivers. From the viewpoint of river transportation, several Brazilian rivers are excellent natural waterways. With some betterment works, they may form an inland transportation network with approximately 25,000 km length. Fig.1 shows Brazilian rivers and inland waterways.

The present work is the result of a survey on the river transportation in Brazil and aims to show its potential, present situation and trends. Problems and challenges are also pointed out. Due to the extension of the subject, the discussion is focused on Tietê-Paraná waterway, which is a strategic link of the most important economical centers of Southern Cone Common Market (Mercosul) – formed by Brazil, Argentina, Urugui and Paraguay.

Fig.1 - Rivers and inland waterways of Brazil.

2. BACKGROUNDS
From the 16th to 18th centuries, explorers and colonizers have used the rivers as natural and main pathways to the inland, through the jungles. In that time, the rivers played decisive roles both in economy and politics of South America countries: exploration of virgin lands and formation of the states. In the 19th century, commercial navigation started in some regions as a result of the up growing economic activities in settlements spreading along the riversides. However, in the middle of the 20th century, as a policy of modernization, absolute priority has been given to automobile industry and transportation by trucks. Spite of some studies carried out in 1960’s and 1970’s have emphasized the importance of inland waterways, according to a CESP report of beginning of 1990’s, transportation by trucks represented 80% of cargoes transported in Brazil, followed by railway with 18%. River transportation corresponds only 2%, a totally unbalanced distribution considering its enormous potential.

Since the last decade, changes have occurred. The high cost of transportation based on truck reduced drastically the competitiveness of Brazilian products in international market. Associated with precarious condition of the roadways, it becomes the bottleneck to the expansion of new agricultural frontiers in the Center-West and North regions of Brazil. Table 1 shows a comparison between typical transportation cost of waterway, railway and roadway in Brazil. The excellent location of the rivers and the ability of waterway mode to carry enormous agricultural and mineral production from inland to the exportation ports through long distance with much lower cost made it the best choice as the backbone of efficient multi-modal transportation systems.

Table 1. Cost of waterway, railway and roadway transportation in Brazil. (Source: CVRD)

<table>
<thead>
<tr>
<th>Modal</th>
<th>Cost (US$/tkm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waterway</td>
<td>0.009</td>
</tr>
<tr>
<td>Railway</td>
<td>0.016</td>
</tr>
<tr>
<td>Roadway</td>
<td>0.056</td>
</tr>
</tbody>
</table>

Moreover, as shown in the case presented by Table 2, environmental impacts caused by implementation of waterways are very small comparing with that of railway and roadway. This advantage is important to preserve the local ecosystem and sustainable development of the new production frontiers. Recently, government and private investments on the infrastructure and increasing usage of multi-modal transportation are bringing prosperity to the waterways.

Table 2. Construction cost of Tocantins-Araguaia waterway and its railway and roadway alternatives.

<table>
<thead>
<tr>
<th>Option</th>
<th>Extension (km)</th>
<th>Deforestation Area (km²)</th>
<th>Digging out materials</th>
<th>Rock (10¹⁵ m³)</th>
<th>Investment (10⁹ US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waterway</td>
<td>2,202.0</td>
<td>0.0</td>
<td>1,100.2</td>
<td>170.9</td>
<td>115.7</td>
</tr>
<tr>
<td>Railway</td>
<td>2,010.0</td>
<td>77.1</td>
<td>116,200.0</td>
<td>3,400.0</td>
<td>1,827.0</td>
</tr>
<tr>
<td>Roadway</td>
<td>2,500.0</td>
<td>100.0</td>
<td>84,750.0</td>
<td>550.0</td>
<td>625.0</td>
</tr>
</tbody>
</table>

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3. TITÊ-TENANÁ WATERWAY

Tietê and Paraná rivers form natural link of São Paulo, the most important economical region of South America, and the rich agricultural region in the Center-West of Brazil (Fig. 2). The area economically influenced by the waterway sums 76 million hectare, about 9% of Brazilian territory. This region incorporates four of five largest agricultural states of the country, fifty million habitants (33% of the country's population), and produce more than 50% of Brazilian GNP.5)

![Fig. 2 - Tietê-Paraná waterway.](image)

The first study on the potential of Tietê and Paraná rivers were realized soon after the Second World War. Over decades, benefited by international experience, particularly the Tennessee Valley waterway in USA, ten dams and ten locks have been built for multiple usages of the rivers that include hydroelectric power, irrigation, tourism and navigation.

The formal inauguration of the waterway was in 1981, with a 273 km navigable course in Tietê River, between Barra Bonita and Itatinga, known as 'alcohol waterway'. In this year, the commercial navigation on Tietê River began with regional transport of sugar cane, construction materials and calcareous. The long distance commercial navigation of Tietê-Paraná waterway started in 1991, after the opening of Pereira Barreto Channel that links Tietê to the north segment of Paraná River.6) This augmented the navigable course to 1,040 km, starting from Conchas, in Tietê River, to São Simão, the northern most port of Paraná River (Upper Paraná). The inauguration of locks in Três Irmãos (1996), Jupiá (1998) and Porto Primavera (1999) 7) dams integrated the south segment of Paraná River. This added about 1,300 km to the waterway and extends it to Itaipu dam, close to the mouth of Iguaçu River, the border of Brazil, Argentina and Paraguay.

Three main inter-modal terminals are located in Tietê River: Pederneiras/Jaú, Conchas/Anhembi and Santa Maria da Serra (Piracicaba). The first and the last have railway connection to transfer cargoes with destination to port of Santos. In Paraná River, the waterway is connected to railways in Santa Fé do Sul, Três Lagoas, Guaíra, Foz do Iguaçu, amount others.

The main cargoes of the waterway are soy and bran, which are carried from inland to inter-modal terminal in Piracicapa, and then by railway or roadway to port of Santos. Fertilizer and calcareous flow in reverse direction. Shorter distance regional transports, but not less important are formed by alcohol, sugar cane, maize, sand, wood and animals.

Embarkations of the waterway are divided into two categories: auto propelled and convoy formed by barges and tug/pusher.8) The later one is dominant. The sizes and arrangement of the convoys are determined by the operating constraints of the waterway including lock dimensions, channel depths, span and height of bridges and maneuvering clearances. The major determining factor in the Tietê-Paraná waterway is lock dimension. In Tietê the maximum dimension of the convoys is LxBxD=137x11x2.5 m. In Paraná, it is LxBxD=216x16x3.0 m. To minimize the problems, the National Department of Waterway (DNTA) recommended vessel sizes and convoy configurations for both the Tietê and Paraná branches of the waterway. In spite the locks of Paraná River allow larger convoys, the Paraná barge width has been set at 8 meters to make it possible to be used on the Tietê.

After oscillating in 500,000 to 700,000 ton per year during the 1980's, the cargoes transported through the waterway reached 2 million ton in 1992 and 6 million ton in 1998. In 2010, it is expected to reach the full capacity of 20 million tons of cargo per year. With freight costs around US$ 0.012/km, it will promote annual savings of 220 million liters of diesel fuel and a freight cost reduction of up to 75 percents.

As parts hydrological basin of Plata River, after the completion of locks of Itaipu dam, it is possible to stretch the waterway to Asunció, Montevideo, Buenos Aires and the sea through the Paraguay River, forming a navigable network of about 7,000 km. Owing to its strategic location, Tietê-Paraná waterway is "the Transportation System through the Heart of Mercosul - Southern Cone Common Market".

4. CLOSURE

Until middle of the 20th century, river transportation has played important roles in the development of Brazil. However, nowadays the potential of its rivers is poorly exploited. Fortunately, changes in production and market allied to environmental concerns are bringing new life to the waterway mode. The fast growing transportation on Tietê and Paraná rivers shows the possibility of constructing an efficient multi-modal transportation system of continental dimension based on waterways in a near future.

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