Paper 151 – Amazon Basin Inland Waterway Transport Aspects

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ABSTRACT: Brazilian transportation mesh greatly varies from region to region. The countries' North region has the most developed inland waterway system with the capability of receiving ocean going vessels due to its rivers big dimensions; however, its connection with two very productive areas, the agricultural Central-West and the industrial South-East, is not well developed. This paper describes Brazilian inland waterways big picture, more focused on the Amazon Basin, and federal government's recent studies and new investment propositions. Following, it presents comments on the current arrangement consequences and later the author's conclusions.

1 INTRODUCTION

When confronting railway and road transport maps with charts of the Brazilian waterways, it is promptly noticeable that they cover distinct regions, such as many countries in face of the differences in climate, vegetation, topography, agricultural production and economic and social development.

The Amazonian rivers have in the East-West axis a great capacity and penetration, reaching more than 3000 navigable kilometers, since the mouth in the Atlantic Ocean. However, the connections with the Central-West region, an area of great agricultural production, and the Southeast region, area of great industrial development, are not well developed.

The tributaries on the right bank are navigable only in the initial stretches, except for the Madeira River, which is now a commercial waterway. In the tributaries of the left bank, this same event happen and mines are located in the initial stretches of the rivers.

An integration with neighboring countries is just a dream.

The end of this isolation of the Amazon Basin relies on the integration of the Railway system projected for the Central-West reaches the navigable Amazon river right bank tributaries.

2 OBJECTIVES

This paper intends to demonstrate the Brazilian waterway system, its characteristics, the most important Brazilian government recent transportation plans and the consequences of the present arrangement not only to Brazil but in a regional perspective as well.

Item 3 starts presenting the Amazon Basin waterway system, its main rivers, transported goods and technical characteristics. Following, item 4 elaborates on Brazilian government most important recent plans and proposed investments. Results and comments for the present situation are shown on item 4. Finally, item 5 closes bringing the author's conclusions.

3 AMAZON BASIN

The waterway transportation in the Amazon Basin, due to its fluvial system extended coverage area, wraps many aspects. It goes from subsistence, with the transportation of small amount of cargo and passengers, until big ventures, like cabotage or long distance navigation. It is normal for ocean going vessels to navigate the Amazon and, besides some ports are located more than 1.000 km upstream, they are often considered maritime ports.

The Solimões-Amazon Waterway is the main Brazilian waterway corridor in terms of transported quantity. Its physical characteristics, resulted from the smooth Amazon topography, contribute to the waterway transportation. In inland navigation oil transportation is highlighted, both in state and interstate routes.

Lastly, the large volume of trips made by vessels up to 2,000 tons, which perform the supply of coastal villages, is vital for the Amazon region since its road network is local. There are no road interconnections due to the large number and size of the rivers. Small

boats perform the navigation in this stretch to meet the supply of riverside villages that do not have road access.

The only existing railways connect the ore mines to their outflow ports, like in Trombetas River, Juriti, Munguba and Santana Port in Macapá.

3.1 *Madeira River Waterway*

The Madeira River Waterway, located in the Western Amazon region, is the only link between Manaus and the Central-West region of Brazil since BR-319 highway, the road connection until Porto Velho, is impassable due to several interrupted stretches.

With 1060 kilometers of navigable extension, the waterway starts in Porto Velho, capital of the Rondonia state, and ends at the port of Itacoatiara, on the Amazon River, in the homonymous state. The average width of Madeira River is 1,000 meters, a condition that enables the navigation of pushed convoys, tug in the back, composed of up to 20 barges of 2,000 tons each during the wet season, from February to May. In the dry season, from July to October, the convoys are smaller, composed by 9 barges.

The Madeira River is still a free flow waterway, ie, it does not have dams and locks. The Santo Antônio dam, when completed, will not affect the downstream navigation of Porto Velho. However, the upstream navigation will not occur.

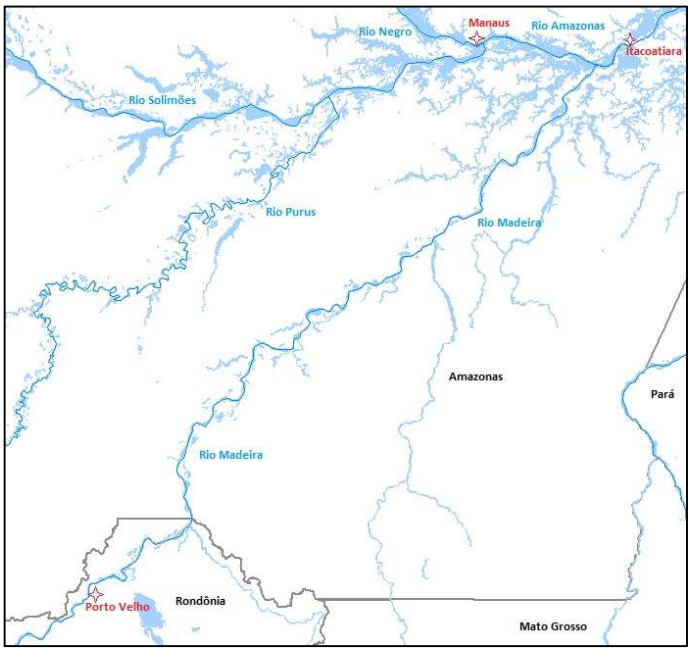

Figure 4: Madeira River Waterway.

The following figure summarizes Madeira river waterway characteristics:

Navigable extension	**1.060 km between Porto Velho and Itacoatiara**
Average width	**1.000 m**
Average declivity	**1,7 cm/km**
Dry season	**July- October**
Wet season	**February-May**
Navigability	**Signaling system / beaconing**
Restrictions	**Sandbanks during the dry season**

Figure 5: Madeira River Waterway Characteristics.

The Madeira River Waterway, the third largest waterway when it comes to quantity transported by inland navigation, transports more than 4 million tons, second only to Solimões-Amazonas Waterway wich is responsible for twice the tonnage. The Madeira River Waterway also stands out for its volume of soybean transported, which corresponds to 55% of total cargo transported on the waterway. The shipping lines that uses the waterway the most are Porto Velho/RO - Itacoatiara/AM, Porto Velho/RO - Santarém/PA and Porto Velho/RO - Manaus/AM.

Two terminals for loading the soy produced in Rondônia are located in Porto Velho, allowing farmers to export by the Amazon River port, becoming a good alternative to avoid the bad conditions of BR-364 roadway, which is the path towards the Southeast ports. Cargill transports soybean to the port of Santarém and Hermosa, a Maggi Group component, to Itacoatiara, whose journey lasts for 55 hours in convoys of 20,000 tons. Itacoatiara port can serve up to 40 barges per week and loads a ship of 40,000 to 60,000 tons in four days. The distance to the sea is 600 nautical miles, around 1111 km, and saves six days if compared to the routes toward the South region of Brazil.

3.2 *Amazonas-Solimões Waterways*

The Solimões-Amazonas Waterway is the main Brazilian waterway corridor regarding transported quantities. Its physical characteristics and the connection with the Madeira and Tocantins-Araguaia waterways contribute to waterway transportation. The oil transport stands out at the inland state routes navigation, more specifically in Coari/AM - Manaus/AM route, accounting for 87.9% of its total traffic. Among interstate routes, the Belém/PA - Manaus/AM line accounted for 72.3% of the total, where the main transported product is the semi-trailer.

As for the cabotage, the main cargo is bauxite. The ore is predominantly transported in the river terminals of the Trombetas River in Oriximiná/PA and Juruti/PA to the Vila do Conde Port in Barcarena/PA and to the state of Maranhão in marine vessels navigating north of Marajó island. At last, on long distance, three products are in evidence: bauxite, containers and soybean.

The following figure presents characteristics of the Amazonas River Waterway:

Navigable extension	**1.646 km between Belém and Manaus**
Average width	**2.000 m**
Average declivity	**2 cm/km**
Dry season	**June**
Wet season	**November**
Navigability	**Signaling system / beaconing**
Restrictions	**Mandatory conduction by a maritime pilot**

Figure 6: Amazonas River Waterway Characteristics.

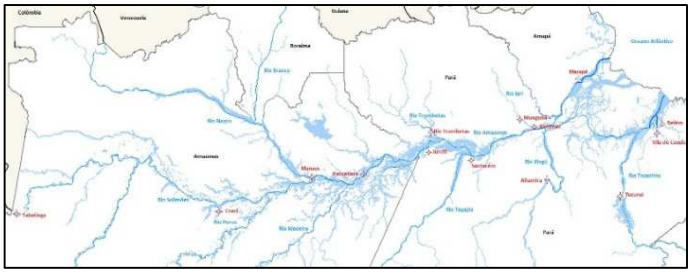

Figure 7: Amazonas River Waterway.

The following figure presents characteristics of Solimões River Waterway:

Navigable extension	**1.630 between Manaus and Tabatinga**
Average width	**1.210 m**
Average declivity	**2 cm/km**
Dry season	**July-October**
Wet season	**February- June**
Navigability	**Signaling system / beaconing**
Restrictions	**Mandatory conduction by a maritime pilot onboard**

Figure 8: Solimões River Waterway Characteristics.

The Solimões-Amazon Waterway carries more than 7 million tons in its interstate flow, stressing the volume of transported soybean, which corresponds to 35% of the total. In terms of cabotage, the Amazon waterway was responsible for an annual flow of 20 million tons. Bauxite is the main transported product, corresponding to 90%. Containers with electronic components and fuel are important transported products by the waterway. In the long range bauxite and iron correspond to 56% of the flow, followed by containers and soybean.

On long distance, bauxite and iron correspond to 56% of the flow, followed by containers and soybean. Finally, the large volume of trips made by vessels up to 2,000 tons, which perform the supply of coastal villages, is the vital transport for the Amazon region since its road network is local, because there are no road interconnections due to the large number and size of the rivers. The only existing railways connect the mines to the ports of outflow of ores, as in Trombetas River, Juriti, Munguba and Santana Port in Macapá.

3.3 *The Tocantins and Araguaia Waterways*

According to a study from CNI (National Industry Confederation – Confederação Nacional das Indústrias) and CNA (Brazil Livestock and Agriculture Confederation - Confederação da Agricultura e Pecuária do Brasil) in 2013, the waterway of the Araguaia River should be preserved as an environmental sanctuary, and the Tocantins waterway, that runs parallel to it, should be utilized. The most important waterway for transportation of cargoes from the state of Mato Grosso is the Tocantins River waterway, which also would meet the logistics demands of Maranhão and Pará, besides the state of Tocantins.

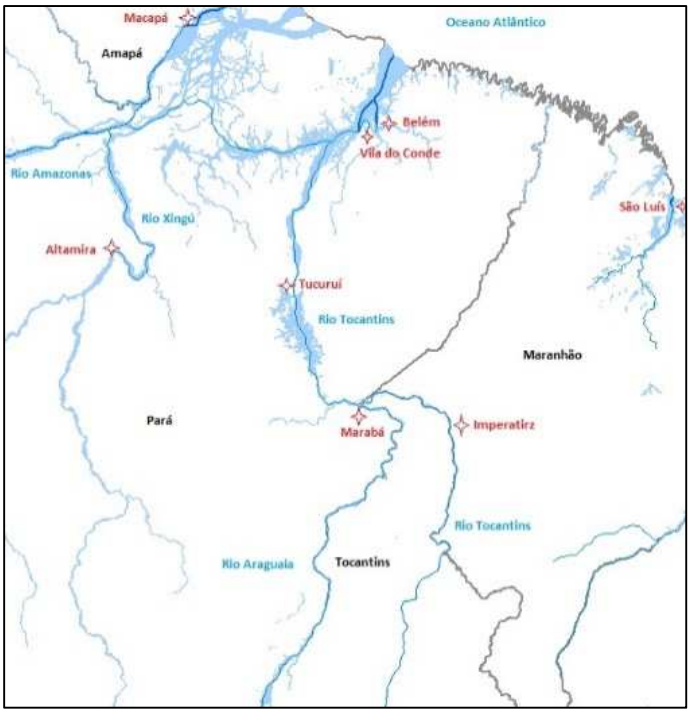

Figure 9: Tocantis and Araguaia Waterways.

This route, however, is impracticable. To enable its use, among other required interventions, is the completion of Lageado Lock construction, the construction of Estreito hydroelectric lock and the demolishing of 43 kilometers in the Pedral of Lourenço. In addition, dredging of Quiriri channel, up to 17 meters, which will allow the port of Vila do Conde to operate with Cape-size vessels type, whose freight cost is much lower compared to Panamax ships currently operated by the port, increasing the flow across the whole waterway.

The study also points out that if the lock is built along with the hydroelectric plant, its cost will be incomparably lower than if built after it, besides the huge amount of extra time the second option would take. The Tucuruí lock, in Pará, is a good example of

wrong planning. That work took thirty years to complete and to a much higher cost than originally planned due to the same mismatch mentioned in the study. Another example is Itaipu, which until now had not built a lock, and consequently makes the navigation through the Parana River towards Argentina impossible. Belo Monte hydroelectric plant is also being built without a lock, which consequently implies the waterway in the Xingu River will have the same outcome.

The waterway transport in the Tocantins River is performed with a commercial relevance only in its final stretch, below the Tucuruí Dam. After 2011, with the start of operation of the locks of Tucuruí, the site came to have conditions for waterway transportation, with long distance navigability performed by high capacity convoys (four barges of 2,250 tonnes, totaling 9,000 t). After the lake, the navigation only occurs during the wet season because the Pedral of Lourenço. Pedral of Lourenço is a large extension of natural obstacles, which makes navigation infeasible on the Tocantins River during the summer months in the Amazon region. Without this construction, the Araguaia-Tocantins waterway will be underused.

The following figure presents the characteristics of the Tocantins River Waterway:

Navigable extension	420 km between Belém and Marabá
Average width	1.000 m
Average declivity	20 cm/km
Dry season	June-November
Wet season	December - May
Navigability	Signaling system / beaconing
Restrictions	Pedral of Lourenço during the dry season
Convoy type	Lenght = 200 m, beam = 24 m, draught = 2,5 m

Figure 10: Tocantins River Waterway Characteristics.

The Tocantins and Araguaia Waterway transports 9 million tons over the long distance and 3 million through inland navigation, according to the Antaq data, but only in the stretch of the waterway that is near to the mouth. The main products transported were ores, mainly bauxite, and petroleum derivatives.

The following figure presents the characteristics of the Araguaia River Waterway:

Navigable extension	1.230 km
Average width	700m
Average declivity	cm/km
Dry season	June- November
Wet season	December - May
Navigability	Signaling system / beaconing
Restrictions	Outcrops of rocks and sandbanks in sparse sections.
Convoy type	Length = 108,3m, beam = 16m, draught = 1,5m

Figure 11: Araguaia River Waterway Characteristics.

4 BRAZILIAN GOVERNMENT TRANSPORTATION PLANS

The transport mesh proposed by the Federal Government in PNLT (National Transportation Logistics Program – Programa Nacional de Logística de Transportes) and DNIT studies (National Transportation Infrastructure Department – Departamento Nacional de Infraestrutura de Transportes) is being put into reality by PAC (Growth Acceleration Program – Programa de Aceleração do Crescimento). Based on the allocation of cargoes and experts' opinions, a works portfolio was elected for PAC and the result is shown in the figures below:

For the railway and waterway system, the investments proposed in PAC were considered, and also the new proposals of connecting several transportation modes, added to the intermodal terminals that will allow good capacity, cost and time transshipment conditions.

Work	Railway
Construction	East-West Integration Railway
Construction	North - South – Açailândia/MA-Belém/PA stretch
Construction	Central-West Integration Railway
Construction / Remodelling	TransNortheast Log
New stretch	Petrolina – Salgueiro
New stretch	Carajás – Rio Xingú
New stretch	Central-West Integration Railway to the Teles Pires River
30 intermodal terminals	Railway integration with waterways and highways

Figure 12: PAC railway investments (2014).

Work	Waterway
Actions and investiments in cabotage	Amazon Basin
Tapajós - Teles Pires	Tapajós River waterway
10 intermodal terminals	Integration of the waterways to the railways
Locks construction	Belo Monte, Jirau and Santo Antônio
Dredging and demolishing	Tocantins River
Dredging, demolishing and signaling	Tapajós River
Dredging of stretches with small depth	Amazonas – Madeira waterway
Dredging and demolishing	Madeira waterway
Signaling renovation – navigation channel	Amazonas – Madeira waterway

Figure 13: PAC waterway investments (2014).

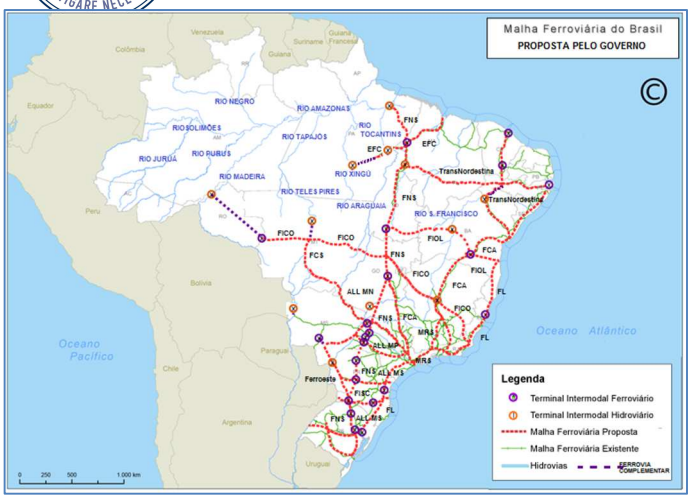

Figure 14: Proposed railway system.

4 RESULTS

Globally, the use of waterways for transporting bulk cargoes is a fact, nevertheless in Brazil this expectation was not put into reality due to several restrictive factors. The production areas of the Central-West and the ports of the North and of the Amazonas River have the waterways as a major advantage at first sight. However, its utilization is subjected to a set of factors, since the waterways are hardly naturally navigable, allowing transport in a safe and economic way.

The transport costs in inland navigation are lower than in other transport modals; however, it requires complementary transportation and highly efficient transshipment terminals. Other aspects that must be considered are the waterways operating all year long, even with restrictions, and the possibility of using convoys with high capacity of cargo.

5 CONCLUSIONS

The waterway navigation has a low unitary freight "cost" in its 15,000 navigable kilometers. Among the several problems are the intense dry seasons, lack of signaling for navigation, the need for maintenance dredging and the lack of terminals for the transshipment of cargoes

In the Amazon basin, river navigation is essential to the movement of people and goods, due to the inexistence of roads and to the capillarity of waterways. In the South and Southeast regions, the main rivers flow directed to west, because of Serra do Mar and Serra Geral and do not reach the ports of the Atlantic Coast, with the exception of the Port of Rio Grande. This fact generates the necessity for the transshipment to highways or railways to reach destinations or ports, which significantly reduces the competitiveness of the waterway navigation. Finally, the lack of integration terminals makes the use of inland navigation limited and restricted.

Another intrinsic problem of navigation in Brazil is the lack of locks on every hydroelectric power plant dam, built with the solely purpose of power generation. Examples are the Tucuruí Lock on the Tocantins River, which was completed after 30 years of works, and the dam of Itaipu, which does not have transposition locks until today. This restrictive policy to navigation results in the existence of only 14 locks in operation in Brazil. The two following paragraphs summarize the inland navigation of Brazil:

Despite the fact that the country can count on large waterways basins, most of the Brazilian rivers need transshipping works, dredging and regulation.

The waterway navigation is completely disconnected from the railways and would requires at least ten multimodal big river-rail terminals to become attractive.

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