



Solar-powered boat for transportation of schoolchildren.

Brazil's Maritime Sector

Tens of thousands of miles of coastal and inland waterways

BY HARLYSSON W. S. MAIA

Brazil has an extensive coast (more than 5,000 miles), very favorable to cabotage (shipping along coastal routes, between two ports in the same country or different countries), as well as an inland network of rivers and lakes of approximately 39,150 miles in length, distributed over 12 river basins. Of 18,000 miles of navigable rivers, only 13,000 miles are part of the logistic system. Although waterways are being used for the transportation of 25 million tons of cargo and 6 million passengers per year, this infrastructure is still under-used.

On inland cargo transportation, for example, the waterway modal use corresponds to less than 15%. Cabotage navigation is realized mainly for cargo transportation between geographically distant ports, for example, between São Luís to Belém, Santos to Rio Grande, Paranaguá and Suape. From 2011 to 2016, the World Bank funded a project with a cost of US\$300,000, "BR Fostering Short Sea Shipping," with the objective of assessing the country's short sea shipping sector, in order to propose actions to promote this mode and improve governance for logistics.

The main ports and population centers are located along the coastline, a natural historical consequence of the territory occupation method, which began in the middle of the 16th century. Major exceptions to this trend are the inland ports in the North region; Manaus, in the State of Amazonas; and the ports of Santarém, Vila do Conde, and Belém in the State of Pará.

The use of waterways for passenger transportation is even more under-used. According to the Inland Waterways Strategic Plan of 2013, the Ministry of Transport pointed out that this mode of transport is more important in the Amazon region, benefiting from the abundance of inland waterways and, in part, the lack of roads in good condition. According to the plan, an increase of 40% in passenger transportation is expected by 2031, with government incentives for fleet renovation and construction of new interior passenger terminals.

Vital waterways

In the Amazon region, waterways are vital to the maintenance of society. Approximately 6 million people use this mode on a daily basis, for commuting, school, and short

and long distance travel between cities through the rivers. According to the National Fund for Development of Education, at least 208 districts all over the country need waterway transportation to keep children in school. Approximately 180,000 children, just in the North region, need to use this mode to reach schools. With several islands and other localities in the region, the only access is through the waters.

Various types of vessels operate in the Amazon region, from wooden vessels, more likely to be involved in accidents, to large steel ships. According to a report by the National Agency of Hydroviary Transport—focused on the federation units that generate more passenger flux through the rivers, Pará, Amapá, Amazonas and Rondônia—there are 602 vessels and 317 fluvial routes. One of the main Amazon routes is Belém-Manaus (889 miles), a 120-hour trip operated by wooden and steel ships with a mean passenger capacity of 400, transporting 72,000 passengers per year. The longest route is Lábrea-Manaus (4,657 miles), through the meandering Purus River, transporting 7,260 passengers per year. The busiest route is Arapari-Belém (10 miles), transporting nearly 1.5 million passengers per year.

There are RoPax lines operating all over the country, mostly on short distance travels, like river crossings and between cities along the rivers. RoPax routes are, for example, Barcarena to Belém (7 miles) and Santarém to Curuai (65 mi) in the state of Pará (North

In the Amazon region, waterways are vital to the maintenance of society.

region), and Ponta da Espera to São Luís (14 miles) in the state of Maranhão. These are modern vessels, generally well inspected and rarely involved in collisions.

As there are no extreme weather conditions like hurricanes and tornados in Brazil, the primary cause of accidents between vessels is human error. According to Brazilian Navy statistics, 72% of accidents were caused by imprudence, malpractice, or negligence. The Ministry of Health has stated that, in the period from 2007 to 2017, there were 1,289 fatalities. The states in the North region accounted for 708 fatalities, approximately 55% of the national registry. Just in the states of Pará (186) and Amazonas (421), in a decade, 607 people died in shipwrecks. In the Southeast region, according to the ministry, in the same period, there were 185 deaths.

In 2003, the vessel *Tona Galea* capsized in the lakes region of Cabo Frio, resulting in 15 fatalities. The boat was transporting 62 tourists and 2 crewmembers when it was hit by a big wave

Save Precious Time and Money Using SNAME's Technical Library

Free access makes it a natural that SNAME's Technical Library is always my starting point for important research. With such a comprehensive resource of naval architecture and marine technology, SNAME saves me time, money, and gives me the complete confidence that I can always find what I need.

David Hansch
Chair
Panel SD-1 (Weights Engineering)

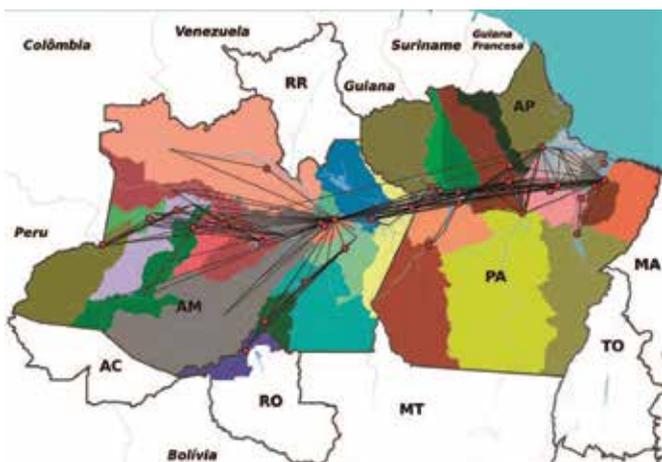


www.sname.org

Brazil's Maritime Sector *continued*



Routes and locations in the North region.



Fluvial traffic zones in the states of Amazonas (AM), Pará (PA), Amapá (AP) and Rondônia (RO), with the delimitation of the areas of influence of each zone according to the operational demands of the navigation lines that operate in each region.

amidships. No one was using lifejackets. A number of irregularities were noted during the investigation of the accident, such as an extension of the hull made in a clandestine shipyard.

In 2008, the collision of the ferry *Almirante Monteiro* with the barge *Carlos Eduardo* on the Amazon River resulted in 16 fatalities. The Federal Public Ministry (MPF) and the Public Ministry of the State of Amazonas pointed out that the commanders of both vessels had enough time to avoid the collision, demonstrating negligence and unprepared operators for waterway transport. The Brazilian Navy reported that the ferry infringed several safety regulations, among them the absence of auxiliary health crew, the embarkation of passengers without proper registration, and the transportation of cargo and passengers in the same compartment. In 2016, a federal court condemned the union and both companies to pay compensation for moral damages to each surviving victim or relatives of deceased victims.

Multiple causes

Also in 2008, the shipwreck of the ferry *Comandante Sales* on the Solimões River (upstream of the Amazon River) resulted in 48

fatalities. The commander, who had been operating the vessel without the required qualification at the time of the accident, was arrested, but was later acquitted by a popular jury. According to the expert report, the main causes of this accident were overcrowding; structural modifications realized without the accompaniment of an authorized technician; insufficient number of life jackets; and an absence of floating rescue equipment or life buoys. The MPF filed a collective civil action against the union and the commander, in which it asked for compensation for material and moral damages to the surviving victims or relatives of deceased victims.

In 2017, the ferry *Capitão Ribeiro* was hit by a waterspout in a rainstorm and sank in the Xingu River, resulting in 23 fatalities and 2 missing. According to the Brazilian Navy, the vessel had authorization to navigate from Santarém to Prainha, but in reality, it was navigating a route three times larger, with 239 miles over that which was permitted. The State Agency for Public Services Control and Regulation stated that the vessel had no authorization to transport passengers. On the day of the wreck, the shipowner said that there were only two passengers on board. Later, he confirmed to the police that in reality, there were 50 passengers. According to the police, the vessel was illegally transporting a car and two motorcycles, had no passenger list, and was storing cargo illegally. Investigations are underway.

Also in 2017, the ferry *Cavalo Marinho I* was hit by large waves (up to 2.2 m) in an unusual rainstorm (19 mph winds, whereas the usual is 4 mph winds) while crossing the Todos-os-Santos Bay en route to Salvador. This led to a capsizing and resulted in 19 fatalities, 59 wounded, and 1 missing. The ferry was not overcrowded at the time. Along with the harsh climatic conditions of the unusual winter of 2017, some irregularities were pointed out. For example, it was noted that there was approximately a ton of loose rocks used as undeclared ballast at the bottom of the hull, which contributed to the capsizing as the rocks dislocated with the wave impacts.

Survivors and relatives of deceased victims continue to pressure the authorities for more inspections of the maritime transport system, as well as for the response of the 46 lawsuits already filed against the company responsible for the ferry. The Brazilian Navy presented a report, highlighting “neglect” and “recklessness” as the main causes of the shipwreck and pointing to the shipowner, the commander, and the responsible technician as probable culprits for the tragedy. There is no record of fatalities on this crossing in the 60 years before this accident.

The Brazilian Navy has stated that, whenever a shipwreck notification is received, the first measure adopted by the local authority is the sending of vessels and mobilization of the necessary means for search and rescue. On another front, an administrative inquiry is established to identify the causes and responsibilities for the accident.

To learn more about ferry safety in Southern Hemisphere nations, see “Disproportionate Numbers,” beginning on page 48 in this issue.

Academic landscape

Brazil boasts six public universities offering undergraduate courses in naval architecture and marine engineering. These are

the University of São Paulo; the Amazonas State University; and the Federal Universities of Pará, Pernambuco, Santa Catarina, and Rio de Janeiro. The three older schools—Pará, Rio de Janeiro, and São Paulo—offer graduate courses as well, with partnerships for research and internships with various institutions around the world.

In terms of innovation in the field, efforts are underway for the integration of waterway transportation in urban mobility. In the city of São Paulo, in the Southeast region, there is a project conducted by the Fluvial Metropolis Group, of the Faculty of Architecture and Urbanism of the University of São Paulo, that would transform the city's dams and rivers into an alternative for passenger transportation—a waterway system that would connect the metropolitan region, integrated with bus lines. The project is still being defined.

Another technology innovation is research on autonomous solar-powered vessels. Holo Brasil (a company based in Rio de Janeiro) developed a prototype powered by solar energy and controlled by a single person on land with a portable computer, capable of unpiloted navigation. The boat is equipped with instruments for various missions, including meteorological, oceanographic, and fluvial data collection. Before the founding of the company, members of the actual team participated in national and international competitions of single-pilot boats powered by solar energy. The company also participated in the construction of a solar-powered boat for transporting schoolchildren in the state of Pará. The 22-passenger piloted vessel was completed in 2014 and is now in operation. The company is now working on two new models: a 2.5 m unit capable of up to 20 hours of autonomous navigation and a 4.5 m oceanic vessel, with autonomy of up to 90 hours. **MT**

Harlysson W. S. Maia is a naval architect and marine engineer with degrees from Federal University of Pará (Pará, Brazil) and Stevens Institute of Technology.

Deeper Dive

To learn more about the Brazilian maritime industry, check out these resources.

"Brazilian Port and Maritime Sectors: Advances and Limitations," by N.F. Felipe. Campo Grande: Geofronter, 2015.

"Inland Waterways Strategic Plan," by the Brazilian Ministry of Transport, 2013.

"Autonomous Boat," by Evanildo da Silveira. Pesquisa FAPESP, issue # 253, 2017. Go to <https://revistapesquisa.fapesp.br/en/2017/08/29/autonomous-boat/>

"BR Fostering Short Sea Shipping," project P127925 by The World Bank Group, 2011. Go to <http://projects.worldbank.org/P127925/br-fostering-short-sea-shipping?lang=en>



Locations of the shipwrecks covered in the text.


Innovation | Safety | Performance

REGULATORY STABILITY ASSESSMENT SOFTWARE



HECSTAB *Offshore*

USER DRIVEN | ENDORSED WORLDWIDE: HECSTAB is a versatile tool for the Naval Architect involved in design and regulatory evaluation of non-ship shaped assets. In addition to traditional fixed-axis free-to-trim calculations, HECSTAB can perform variable heeling axis (free twist) calculations, greatly reducing the number of calculated conditions.

www.herbert-abs.com