AMAZÔNIA CONECTADA: A NEW APPROACH TO INACCESSIBLE REGIONS OVER THE AMAZON BASIN

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Abstract: The Amazon basin covers an area of about 7,500,000 km^2 over eight countries and is home to more than 30 million people living across a vast region subdivided into nine different national political systems. The Brazilian National Research Network has developed the Connected Amazon Program, which aims to connect 52 municipalities of Amazonas in Brazil through subaquatic optic fibre cable. This paper will discuss the work carried out so far by EGS and its partners and the particular challenges faced in a cable route survey through Amazon river and its tributaries.

1. INTRODUCTION

About 99% of all worldwide internet and telephone communication and/or data transfer are made through fibre optic submarine telecom cables [1]. As world population grows, the internet continues to expand and the need for new submarine telecom cable system becomes essential to keep up the pace for superfast bandwidth. However, the increase in capacity does not always translate into an increased improvement of services in recondite regions.

One of these examples is the Amazon region drained by the Amazon River and its many tributaries. The Amazon basin covers an area of about 7,500,000 km^2 over eight countries [2], namely Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela. The Amazon region is home to more than 30 million people living across a vast region subdivided into nine different national political systems [3].

From that perspective, the Brazilian National Research Network (aka Rede Nacional de Pesquisa – RNP) has developed the Connected Amazon Program. The idea behind the project is to connect 52 municipalities of Amazonas State, in Brazil, through subaquatic fibre optic cable.

2. THE CONNECTED AMAZON PROGRAM

The Connected Amazon Program network aims to link the capital of the state of Amazonas (Manaus) to several cities in the Western Amazon Basin. Figure 1 shows in red the capacity already installed by sections and in yellow the sections yet to be implemented.

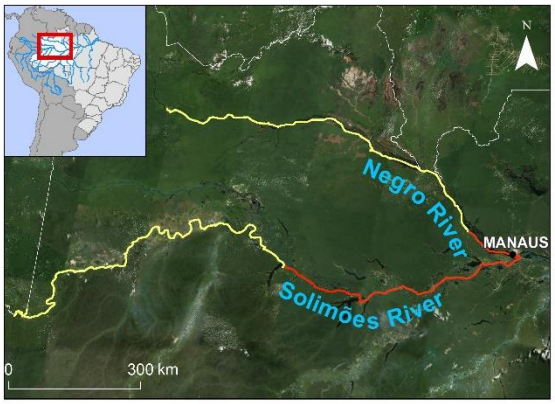


Figure 1: Connected Amazon Program Overview

The overall project will provide five strategic infrastructures (Alto Solimões, Alto Rio Negro, Madeira, Purus and Juruá) with a total of 7,650 km of fibre optic cable with 24 pairs of fibres. For now, about 850 km of fibre optic cable has been installed between Tefé (along the Solimões River) and Novo Airão (along Negro River) [4].

After the program conclusion, it will be possible to offer a series of data network services to the inland population of Amazon state with the same quality as Manaus, the capital, in various thematic such as telemedicine, e-learning, enhancement of tourism, increase of public security and national sovereignty level, and combat to drugs and weapons traffic throughout the national borders.

3. RIVER CABLE ROUTE SURVEY

EGS Brasil Ltda was responsible for acquiring more than 550 km of hydrographic, geophysical and environmental data over Amazon Basin, through Solimões and Negro Rivers, between the municipalities of Coari and Manaus and Novo Airão and Manaus.

For the route survey, it was utilized an interferometric system to provide high-resolution bathymetry and riverbed imagery, 2-10kHz resonant sub-bottom profiler, overhauser magnetometer, sediment grabber and a multiparameter probe for physical and chemical water analysis (temperature, oxidation reduction potential, pH, dissolved oxygen, electrical resistivity, total dissolved solids, salinity and velocity).

The survey vessel consisted of a pleasure yacht with 30m LOA, 6.9m beam and 1.1m draught. The vessel had 30 berths and ample space to operate all the equipment, which apart from the towed magnetometer, used to pinpoint Petrobras pipelines and Eletrobras cables, all survey spread was mounted over the side.

Figure 2: Amazon Adventure survey vessel.

4. RESULTS

High volume of geophysical of data was acquired in order to provide the best route for the submerse telecom cable system known as Vitória-Régia (*Victoria amazonica*, a water lily species) Paulo Sussumo – VRPS system.

The main results found during the survey are described in Table below and in Figures 3 to 5.

SURVEY	MAIN RESULTS
Bathymetry	The bathymetric data revealed isobaths reaching up to 90 m WD at Negro River.
Seismic	In Solimões River two seismic units (Unit 1 and Unit 2) were interpreted, according to the acoustic signal pattern. It was also observed possible hard substrate related to consolidated sediments in a few sections of the route. In Negro River two units were also interpreted. In most part of the section, the reflectors show diffuse pattern and may be related to sandy sediments. Close to the anchorage area, it was

	observed plan-parallel reflectors indicating muddy deposition.
Sonography	It was possible to observe megadunes up to 5m height with a wavelength up to 125m. These dunes are formed perpendicular to the river current direction and are closely associated to the strong currents that flow in both rivers.
Sedimentology	Sedimentary samples presented predominance of fine SAND with variable organic fractions.
Physical-Chemical data	Negro River presented greater values of temperature, DO, Eh and currents velocity; while Solimões River presented higher values of pH, ES and TDS, comparatively.

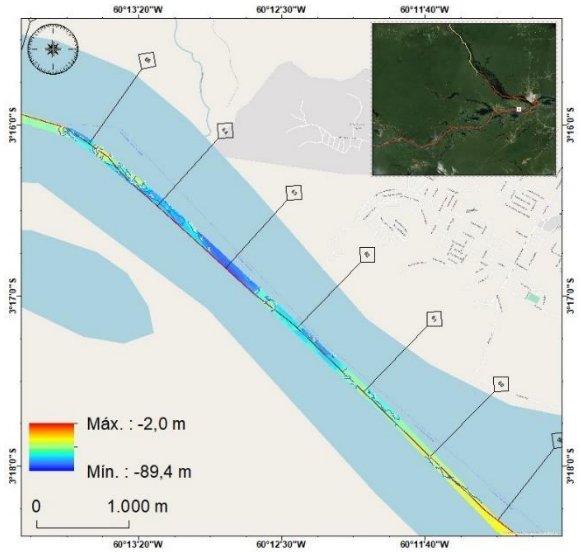
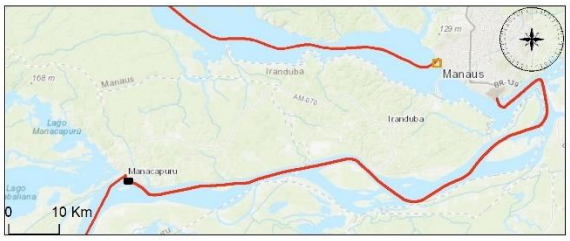


Figure 3: MBES data at Solimões River section

Isobath varying between 40-60 m depth at Solimões River section.



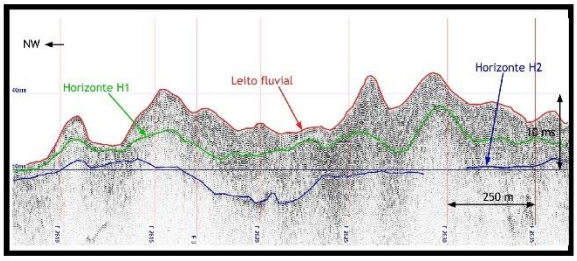


Figure 4: SBP data at Solimões River section

Well demarcated riverbed, followed by the horizons H1 and H2. The first layer, unit U1, presents diffuse reflection and high signal amplitude. In the layers below, unit U2 and U3, internal reflectors with diffuse pattern and greater amplitude of the acoustic signal are observed.

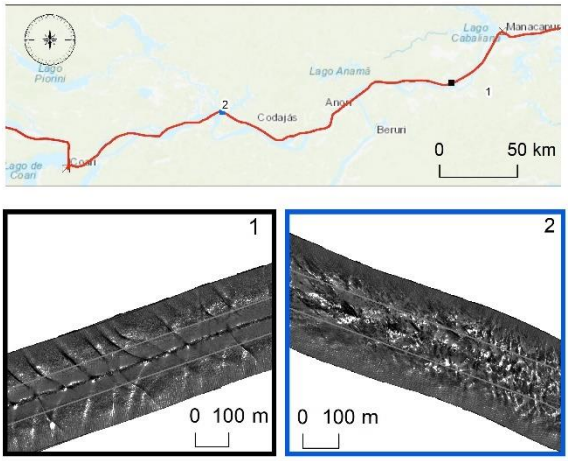


Figure 5: SSS data at Solimões River section

Mega ripple marks (between 0.5 and 25 m) and sand waves (> 25 m), arranged at regular distances. Rough texture pattern could also be observed, with variations in the riverbed forms, corresponding to erosive regions and/or with great riverbed mobilization.

The cable route surveying in the Amazonian rivers comprehend as much difficulties and challenges as those presented by the offshore survey. To be mentioned, lack of previous scientific information about the river's geology, uncharted submerse sandbanks and dynamic dunes, hydrodynamics and outdated nautical charts, strong river currents and eddies and tree trunks and other plants floating on the water are some of the issues the management and survey team faced during the operations.

There was also a high level of piracy undergoing in Amazon rivers at the time of the survey. Being a project supported by the Brazilian Army, a platoon heavily armed was supplied by CMA (aka Amazon Military Command) the survey team and its assets remain free from attacks nor bothered throughout the survey that last approximately one month. The platoon remained aboard the vessel during the survey.

In addition, during the DTS phase quite a lot of several sensitive and protected areas were spotted which had to be avoid during the survey, as well as archaeological sites constantly being discovered along the river margin and aggressive fishing activities.

Another great technical challenge faced by the survey team was to reduce the bathymetric data to a chart datum along the whole route through rivers and tributaries that has quite distinctive behaviour in terms rain run-off. We have used pressure sensor gauges and limnimetric rulers set along the rivers to monitor the water level combined with the Goddard model derived from a DGNSS. The satellite altimetry and liminimetric rulers / pressure sensors cross-referenced with GNSS-RTK benchmarks played vital role in achieving truthful results.

5. FINAL REMARKS

The difficulties faced during the project lead to new surveying and cable laying procedures specific to the Amazon rivers.

Analysing from a more holistic view the Connected Amazon Program, fibre optic cables laid along the Amazon river and its tributaries can easily, safely and cost-effectively sweep enormous distances across the Centre-Northern South America continent serving capitals like Macapá (AP), Belém (PA), Manaus (AM) in Brazil, to Iquitos and beyond in Peru.

In addition, once cables reach Iquitos region, it may even be used a combination of waterways and highways to cross the Andean mountain range and reach the Pacific Ocean in Labayeque, a prolific Oil & Gas region in Northern Peru.

6. REFERENCES

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