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## RIVER HYDROGRAPHIC SURVEYS IN PERU

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The Directorate of Hydrography and Navigation, through the Amazonian Hydrographic and Navigation Service, carries out hydrographic surveys of the navigable rivers of the Amazonian Basin. One of the most important rivers is the Amazon River, which is the longest (3,762 km), with a flow of 50,000 m<sup>3</sup>/sec. It originates in Peru, at the confluence of the Marañón and Ucayali Rivers, 121 km from Iquitos City.

The Amazon River carries extraordinary amounts of debris and geological material which are important in the formation of the river bed. For that reason, the river bed's is undergoing continuous hydromorphological changes that should be recorded and/or monitored in accordance with the available tools. In that respect, the Amazonian Hydrographic and Navigation Service uses the latest technological advances, such as satellite images, together with field surveys.

Thus, the Amazonian Hydrographic and Navigation Service carries out hydrographic surveys of all the rivers of the Peruvian Amazonian, whose freshets (swelling) and low water (ebb tide) change throughout the year; therefore a survey schedule of the rivers is prepared, preferably for the months that are in full freshet.

The technical specifications set down by the International Hydrographic Organization and the special instructions delineated by the Directorate of Hydrography and Navigation are the principles used to carry out the surveys. The Amazonian Hydrographic and Navigation Service uses a hydrographic vessel BAP STIGLICH and five fast launches with outboard motor boat, equipped with data automatic acquisition systems (HYPACK). These systems are interfaced with a last generation digital bathymetric echo sounder and a DGPS OMNISTAR positioning system that allows the differential position signal to be received directly from a geostationary communications satellite onto the hydrographic vessel, thus bypassing the earth differential station. Also, data of the river levels is obtained using water level recorders and digital liquid-level recorders installed in different places along the Amazonian rivers.

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FIG. 1 BAP STIGLICH

### Characteristics of B.A. P "STIGLICH"

Length : 30 m  
 Beam: 8 m  
 Draft: 4 ft.  
 Hull: without keel  
 Two main engines CATERPILLAR (125 HP)  
 Two electric generators (85 HP)  
 JRC High resolution radar JMA 6252-6 model  
 One SPERRY SR -130 master gyrocompass  
 OMNISTAR DGPS Satellite Geodesic Positioning System  
 RAYTHEON Echosounder, four channels with digitrace

### Pilot Charts

Pilot charts are nautical charts designed for navigation on the Amazonian rivers. They produced on board an operating vessel. The contour of the seashore and islands is obtained through continuous overlays carried out and supported by a radar. Meanwhile, sounding lines are obtained through a continuous recording echo sounder, which has four multiple transducers installed below its flat keel.

The **HYPACK** automated system is used for hydrographic surveys and Pilot Charts edition. This system stores in a computer the position and soundings, which are delivered in digital format by the DGPS and echo sounding equipment.

When a ship carries out such a hydrographic survey, it sails along the thalweg of the river. If further information is required, hydrographic surveys of cross legs at interval of 500 to 1,000 meters are performed using a small vessel equipped with a laptop computer, echo sounding, GPS system and HYPACK software.

When producing charts, the graphics of the rivers obtained during the surveying are adjusted on every section sailed between two points, the position of which is known. This prevents the graphics to be stretched or shrunk beyond control. Thanks to the GPS network it is not necessary to make the aforementioned adjustment.

The soundings are reduced to a maximum ebb current. In many cases, this level has to be estimated because of the lack of historical data on river levels.

Pilot charts are aids to navigation and are designed to show the navigators the approximate datum of the least depth that will probably be found when sailing in extremely low water time; they also help to estimate the depth at any other time.

Also, these charts show the navigable channels as well as a minimum toponymy indicating coastal towns, tributary rivers, islands, remarkable geographic features, dangers to navigation, etc.

The field data is analysed and processed, making the appropriate corrections to each day of surveying. This data is complemented with satellite images, which are analysed and interpreted using the following processes:

- **Geometric correction.** In some cases, the method of manual control points collection is used; in other cases, if there is a geo-referenced satellite image of previous years available, an image-to-image method is used;
- **Filtration.** Its main purpose is to eliminate the noise of the image. Different kinds of filters are used according to the conditions represented by each image;
- **Mosaic.** Radiometric changes, which exist between the images, are taken into account in order to make the mosaic. An appropriate balance is used in all the images so that the grey colour has an homogenous distribution.
- The personnel of the Amazonian Hydrographic and Navigation Service is constantly updated, by thorough training, on the latest technological advances related to hydrographic software and equipment. As a result, the Service is able to carry out important surveys for international companies (Shell, Mobil) as well as for Peruvian public bodies.