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**ORIGINAL ARTICLE**

# Rapid Assessment Survey Using Side Scan Sonar: International Obligations and Role of Hydrography in Ensuring Safety of Navigation – Case Study of the Aftermath of MV X-Press Pearl Incident

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ABSTRACT

The International Maritime Organization (IMO) was established in 1948 as a specialized agency of the United Nations (UN). They provide international standards on the safety, security, and environmental performance of ships involved in international trade. International shipping is effective only if the regulations and standards are agreed upon, adopted and implemented on an international basis. IMO Instruments Implementation Code (III code) is one such attempt where it looks into states' capacities of implementing obligations. Here, we present in what way the hydrographic rapid assessment survey support the above obligation of ensuring safety of navigation for ships visiting Colombo Port in the aftermath of MV X-Press Pearl accident in West coast of Sri Lanka. The comprehensive Side Scan Sonar (SSS) survey that was conducted over the area found some of the fallen containers and debris lying on the seabed. Due to the extent and the nature of the incident, and due to the ocean current dynamics, a larger area had to be investigated and a number of relevant agencies in the maritime field were involved. As a country, the responsible authorities have taken timely actions to disseminate the safety related information to the mariners and subsequent measures were taken to update the relevant nautical charts by conducting necessary systematic hydrographic surveys to fulfill the obligations of the International Convention for the Safety of Life at Sea ( SOLAS) of IMO.

## 1 Background

Colombo Port is emerging as one of the busiest ports in the region and currently ranks among the top 23 ports, which handles over 7 million TEUs (Twenty-foot equivalent units) in a year (SLPA, 2021). Therefore it is a significant terminal in Asia due to its strategic position in the Indian Ocean. The main navigation channel of the Colombo Port is 20 m deep, which serves the purpose of a connecting link between the ocean shipping lanes and the deep water of the port. The reliability of the ship channel is important for commercial navigation where optimal draft can be assured to maximize shipment (MNZ, 2020). Therefore it is being surveyed frequently and dredged by the Sri Lanka Ports Authority (SLPA) to maintain its charted depth.

This is a very critical operation which ensures the safety of all the ships that transit through the channel, since the minimum under-keel clearance must be maintained (FIG, 2010; Lekkerkerk and Theijs, 2011). Necessary Hydrographic surveys are conducted by the Navigation Division of SLPA, and the updated charts for entry to the Colombo Port area are available both in paper and electronic (ENC) forms, satisfying the IMO requirements which are maintained by National Hydrographic Office (NHO) of Sri Lanka. These charts are available for all commercial ports around the island, satisfying the obligation of coastal states according to IMO SOLAS Chapter V Regulation 9 - Hydrographic Services. In particular to carry out, as far as possible, the following nautical and hydrographic services in the manner most suitable for the purpose of aiding navigation (Attard et al., 2016; IMO, 1974): Surveys need to satisfy the requirements to issue nautical publications, to disseminate notices to mariners, and to provide data management provisions to support these services.

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For the above purposes, relevant authorities in Sri Lanka are adequately equipped to conduct surveys in which the Side Scan Sonar (SSS) is commonly used. The SSS is an acoustic imaging device used to provide wide range, high resolution images of the seabed. It enables a more complete and detailed description for safer navigation and other uses. SSS provides rapid qualitative investigation of the seabed. Sonar graphs provide better knowledge to differentiate the type of material and texture of the sea bottom with the help of ground truth sampling. In port surveys, SSS is essential to detect debris and other obstacles that may obstruct in maintaining the necessary keel clearance for shipping channels, and other installations in oil and gas industries (IHO, 2005).

The onset of fire on the MV X-Press Pearl was reported on 20th May 2021. As a consequence, all port operations were threatened as this debris could cause navigation hazard to vessels coming in to the port. Therefore, there was an urgent need for an investigation to be carried out in the ship channel. Usually, in these types of operations, a full-bottom search is required so as not to miss any objects threatening to navigation (IHO, 2020). SLPA contacted Sabaragamuwa University of Sri Lanka (SUSL), seeking the necessary support. With that, a joint survey was conducted immediately with the Navigation Division of the Ports Authority to ensure the safety of ships visiting Colombo Port in the month of June 2021.

## 2 Methodology

The following two zones were identified and given priority for the rapid assessment survey which would identify and locate any object that may be scattered due to the MV X-Press Pearl incident (Fig. 1).

(a) Main navigation channel of the port (Zone A, 9 km x 0.5 km).

(b) Block adjacent to the MV X-Press Pearl shipwreck (Zone B, 1 km x 1 km).

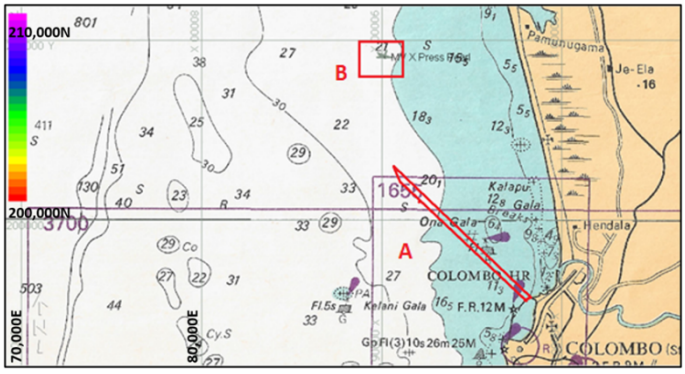


**Fig. 1:** Targeted Hazard Assessment Survey Areas - Zone A and Zone B (using the Kandawala datum)

For this operation, the Imagenex YellowFin 872 SSS system belonging to the SUSL was used with the Hypack hydrographic software (Fig. 2).

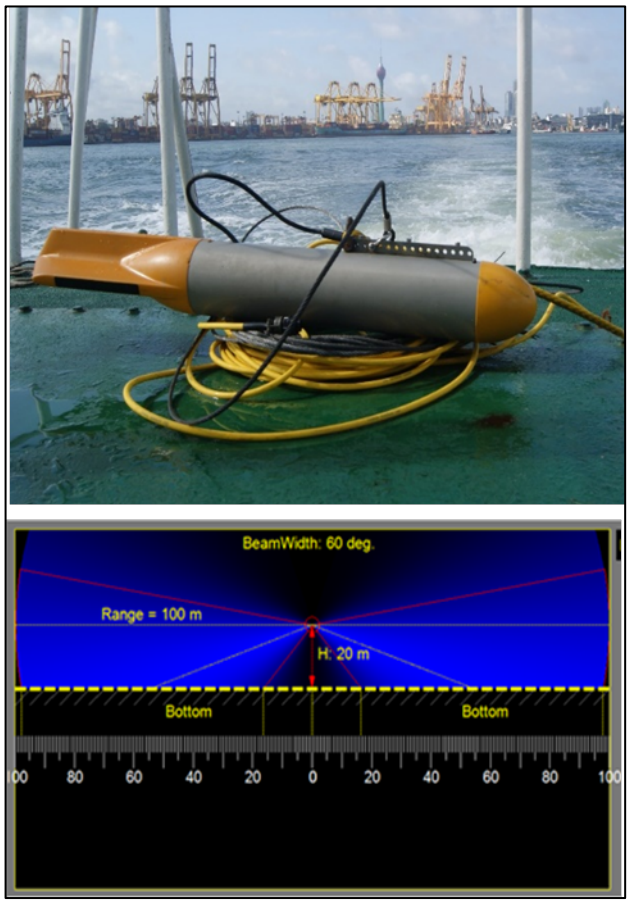


**Fig. 2:** YellowFin 872 SSS -top, and its beam coverage - bottom

YellowFin 872 SSS can operates with 3 frequency configurations; 260, 330, 800 kHz. In this study, we used the medium frequency (330 kHz) configuration, which has a high beam resolution of 1.8° along track, and 60° wide beam coverage across track to ensure maximum range coverage up to 100 m. Several modifications (for towing and side mounting) had to be done to fix the SSS system firmly to the survey boat. Sub-meter accuracy Differential Global Navigation Satellite Systems (DGNSS) positioning system with GPS Aided GEO Augmented Navigation (GAGAN) corrections was used for positioning the sonar and navigation.

To confirm that a full bottom search was carried out, 200% coverage was maintained between the lines. This was critical so as to cover the typical un-ensonified nadir area of the SSS image just below the track line of the tow fish. The effective range for the SSS was set to 80 m for better resolution, and the line spacing maintained was 50 m. Initially, the SSS was towed from the stern of the boat, but the data quality was unacceptable due to the rough sea condition. Therefore, a side mount option was used later during the survey (Fig. 3).

Part of the navigation channel (Zone A) and the area near the accident (Zone B) were investigated. The acoustic images were processed, and a geo-referenced mosaic was developed. Afterwards, the measurements were made for each identified object based on the slant range and the object shadow using the side scan processing tool available

in the Hypack software. Here, ground truthing of the results were not done as the scope of the study was to only investigate the navigation hazards of the area.

**Fig. 3:** SSS data collection: top- side mounted SSS, and bottom – real time raw data display during the survey

## 3 Results

During the 4-day survey period, the sea conditions were not that favorable for a smooth hydrographic survey due to the onset of monsoonal rains, which in turn affected the quality of acquired data. The observed objects show distortion in the images from SSS. The total area surveyed was about 4.5 km$^2$ in Zone A and 1 km$^2$ in Zone B.

No targets were detected in Zone A. However, a total of 24 objects were identified in Zone B, which included several fallen containers (Fig. 4) and other debris laying on the seabed about 8 km towards North from the end of the channel where the MV X-Press Pearl was grounded. These debris might be from the damaged containers or parts of the ship's super structure. However, the pitch and roll effects were prominent along the middle section of the SSS data due to the rough sea conditions.

Most of the objects found showed to be having a rectangular/linear shape of about from 9 m to 12 m in length, spread out within a 900 m stretch towards West from the MV X-Press Pearl shipwreck (Fig. 5). The identified objects were overlaid on the nautical chart of Approaches to Colombo Harbor (INT 7 383).

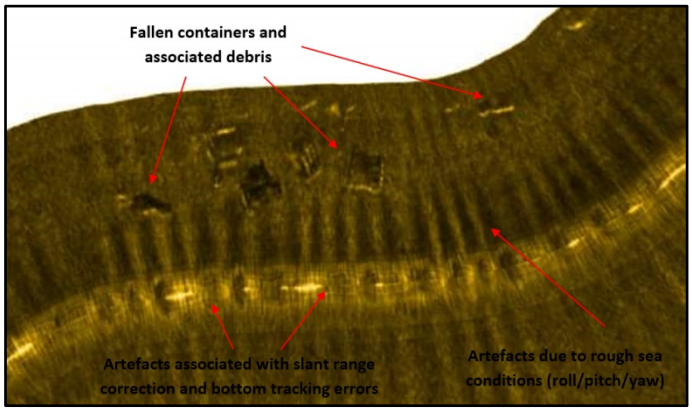


**Fig. 4:** Some of the fallen containers and debris from the MV X- Press Pearl captured by SSS imagery

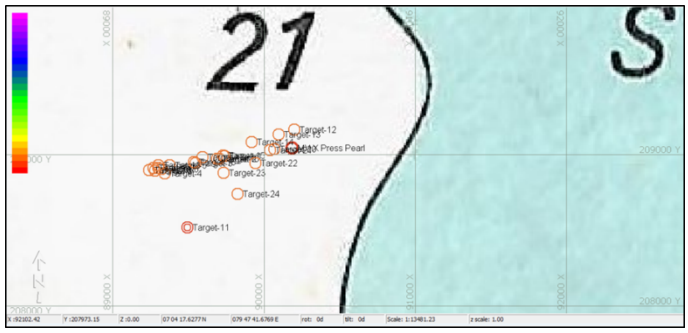


**Fig. 5:** Higher density of objects observed near the MV X-Press Pearl shipwreck location; overlaid on the nautical chart of Approaches to Colombo Harbor (INT 7 383).

## 4 Discussion and Conclusions

SLPA initiated the initial safety related notices to mariners prior to the rapid assessment and informed to the Navarea VIII Coordinator, India. They then disseminated the initial warning advising mariners to keep well clear off the location 70° 04'N, 79° 45'E, and exercise caution where the location was 4 km off the main navigation channel. This is the best practice that any port needs to adopt according to the IMO SOLAS Chapter V Regulation 4. This is also in-line with the guidelines on the IMO/IHO World-Wide Navigational Warning Service adopted by the resolution A 706(17), as amended.

After the subsequent series of warnings at the time of this report, the enforced Navarea VIII warning read "MV X-Press Pearl shipwreck in position 70° 04.87' N, 79° 46.77' E, following a fire onboard. All vessels were advised to keep well clear and exercise caution in the area. Affected charts were INT 32 263 and INT 7 383." Additionally to the above action, SLPA decided to carry out a rapid assessment survey to further ensure navigational safety of the ships visiting the port of Colombo.

Since no significant objects were detected in Zone A - the navigation channel, MV X-Press Pearl incident has caused no immediate impact to the safety of ships transiting through the main channel of the Colombo Port.

However, it was found that all the objects detected were scattered within 900 m adjacent to the MV X-Press Pearl shipwreck. This result was further supported to validate the current enforced Navarea VIII warning, stating that the "MV X-Press pearl shipwreck in position 70° 04.87' N, 79° 46.77'E following a fire onboard, and vessels are advised to keep well clear and exercise caution. Affected charts are INT 32 263 and INT 7 383". Therefore, this action ensures the safety of navigation of the ships visiting Colombo Port.

Finally, the rapid hazard investigation survey conducted using the SSS technique in the ports limit confirmed that it was safe for day to day operations. However, it is suggested to survey the entire coastal area, including the port anchorage, in a systematic manner for a full detailed investigation. This way, any future threats, for example dragging debris subjected to sea currents, can be detected. The located debris can be recovered and stored at a salvage yard if necessary, to minimize adverse environmental impact. Therefore it is possible to ensure that the area is clear for any ships anchoring and also for local fishing activities. This operation has already been started by the National Hydrographic Office (NHO) of the National Aquatic Resources Research & Development Agency (NARA) and Sri Lanka Navy (SLN), collaborating with other relevant maritime administrative authorities of Sri Lanka. These activities may take a few more months to complete and update the relevant nautical charts accordingly. These findings were shared with the working group appointed by the government of Sri Lanka for further actions and necessary investigations.

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## Author Contributions

Conceptualization, methodology, analysis, writing - original draft preparation, review and editing by A.N.D.P. and M.D.E.K.G. All authors have read and agreed to the published version of the manuscript.

## Conflict of Interest

The authors declare no conflict of interest.

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