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Multi-Sensor Hydrographic Survey and Formal Safety Assessment of Navigation Risk in Five Cowries Creek, Lagos, Nigeria

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Theme: Innovations for Sustainable Development and Resilient Infrastructure



OUTLINE

Presentation Outline

01 Introduction and background

02 Problem statement, aim and objectives

03 Survey design, instruments and processing

04 Results: depth, seabed and uncertainty

05 Navigation risk and recommendations

06 References and acknowledgements

INTRODUCTION

Background to the Study

- Five Cowries Creek is the principal inland waterway link between Lagos Harbour and the Lagos Lagoon: about 9 km long, crossed by three fixed bridges
- The Five Cowries Terminal at Falomo is among the busiest ferry terminals in Lagos, and traffic is rising on a newly buoyed channel
- The only systematic depth record is a decade old (Afonja et al., 2016), and national charting does not extend into the creek
- Lagos inland-water safety studies remain qualitative and are not located in space

THE KNOWLEDGE GAP

No tide-reduced multi-sensor baseline, no published uncertainty budget against the hydrographic standard, and no structured navigation risk assessment exists for any Lagos creek.

This study supplies all three for Five Cowries Creek and ranks the risk control options that follow from them.

INTRODUCTION

Problem Statement, Aim and Objectives

PROBLEM STATEMENT

A busy, recently buoyed urban waterway is being managed on a decade-old single-beam depth record, with no seabed hazard survey, no uncertainty budget and no quantified assessment of navigation risk.

AIM

The aim of this study is to establish an integrated multi-sensor hydrographic baseline for Five Cowries Creek and to assess its navigation risk within the IMO Formal Safety Assessment framework.

OBJECTIVES

1. To survey the creek with single-beam bathymetry, side scan sonar and a towed magnetometer
2. To produce a chart and terrain model and test conformance with IHO S-44 Order 1a
3. To characterise tidal and current conditions and their effect on depth reduction
4. To apply the Formal Safety Assessment framework and rank risk control options

METHODOLOGY

Survey Design, Instruments and Processing

1 Data acquisition

Single-beam sounding (3 Aug 2026), side scan sonar (4 Aug) and a towed magnetometer (25 Jul)

2 Processing

Cosine-interpolated predicted tide, dilution-of-precision and median filtering, 2 m terrain model, 0.5 m contours

3 Analysis

Slant-range corrected mosaic, 601 s rolling-median magnetic residual, one-dimensional Saint-Venant tidal model

4 Assessment

A priori S-44 Order 1a uncertainty budget and the IMO Formal Safety Assessment

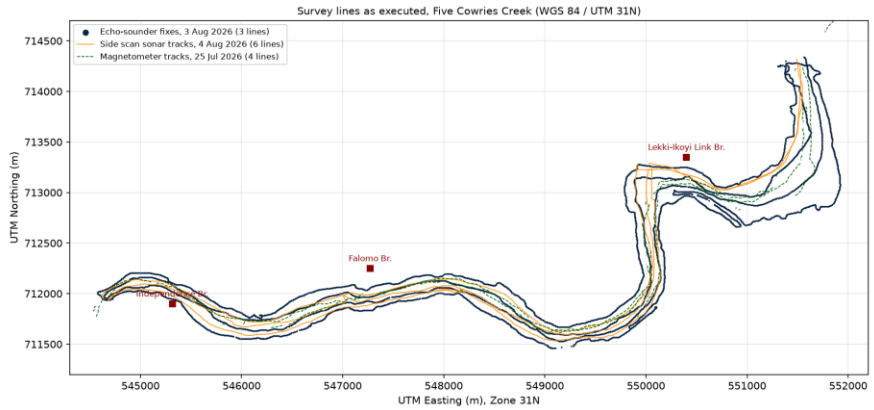


Figure 1: Survey lines as executed — echo-sounder fixes, side scan tracks and magnetometer tracks, with the three bridge crossings.

KEY SPECIFICATIONS

Five Cowries Creek; 9.4 km centreline

6,240 of 6,430 fixes accepted; 27.1 km side scan

WGS 84 / UTM Zone 31N; provisional MLLW

IHO S-44 Order 1a; IMO FSA (2018)

RESULTS

A Continuous Channel of 7–8 m Runs the Length of the Creek

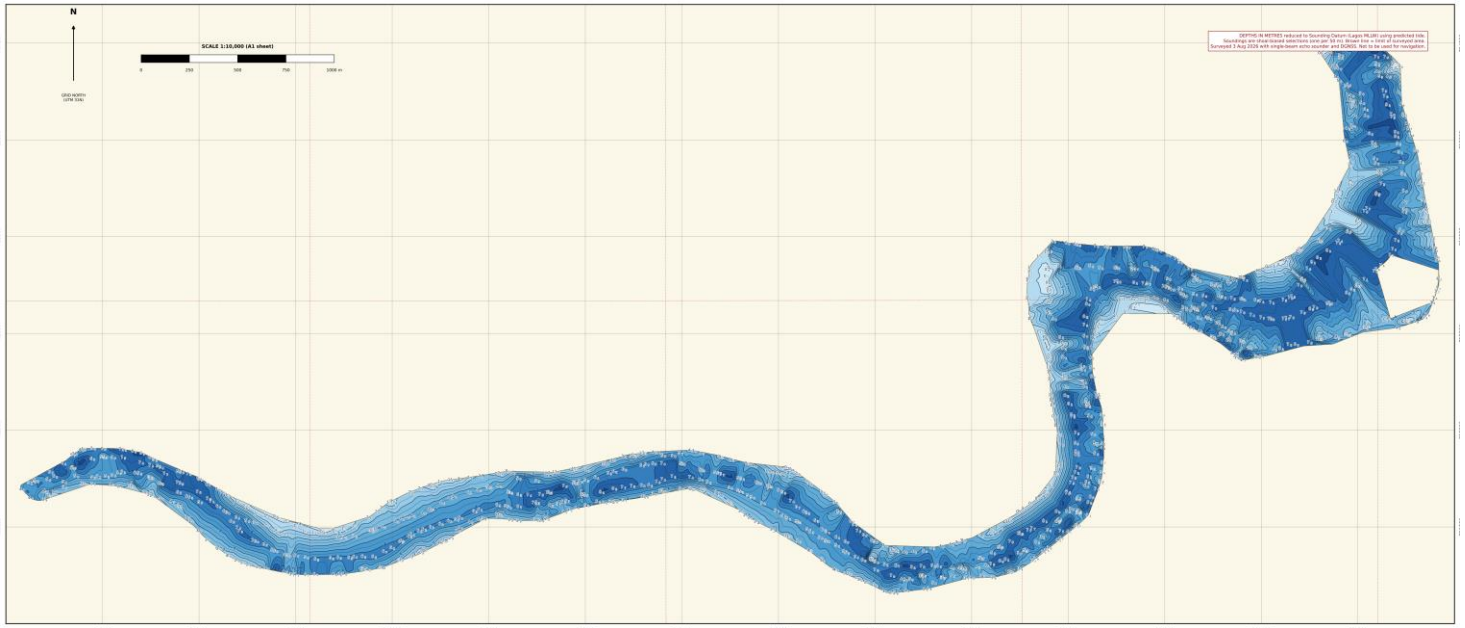


Figure 2: Compiled bathymetric chart of Five Cowries Creek; soundings reduced to provisional MLLW, 0.5 m contours.

KEY FINDING

0.54–8.53 m

range of the 6,240 accepted reduced depths (mean 4.90 m), with 7–8 m along the thalweg of every reach

- 0.17 km² of margin is shallower than 2 m, including a 0.081 km² platform beside the Lekki-Ikoyi Link Bridge
- The navigational constraints are lateral and local, not a lack of depth along the axis

RESULTS

Shoaling Is Confined to the Margins of Three Reaches

Reach	n	Mean (m)	P90 (m)	% < 2 m
R1 Marina–Independence Br.	448	5.60	7.66	0.7
R2 Independence–Falomo Br.	1,298	4.39	7.05	15.8
R3 Falomo–Lekki-Ikoyi Br.	1,065	4.96	7.36	5.4
R4 Lekki-Ikoyi approach	1,004	4.14	7.72	27.9
R5 Lekki-Ikoyi Br., E. basin	1,397	5.44	7.73	9.8
R6 North-eastern arm	1,028	5.18	7.98	10.5

Table 1: Reduced-depth statistics by reach (metres below provisional MLLW).

WHAT THE TABLE SHOWS

The 90th-percentile depth is 7.0–8.0 m in every reach: the central channel is uniform along the whole creek.

The Lekki-Ikoyi approach (R4) is the shoalest section, with 27.9% of soundings below 2 m.

Modelled spring velocities of 0.7–1.0 m/s keep the axis mobile, so deposition is confined to the margins.

RESULTS

Thirty Acoustic Contacts and Twenty-Six Magnetic Anomalies

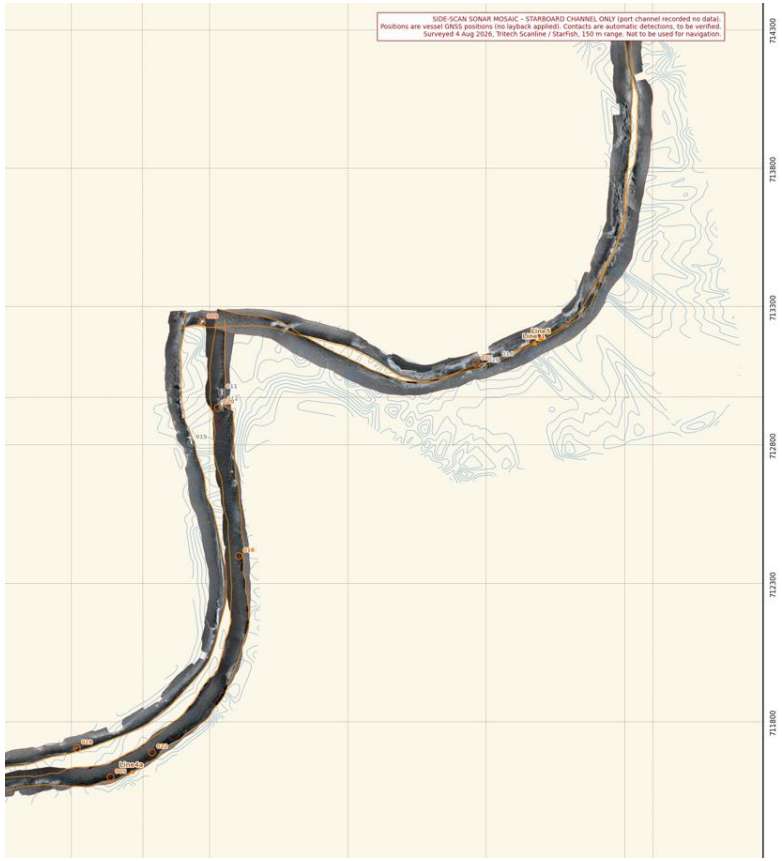


Figure 3: Starboard side scan mosaic of the eastern reach, with tracks and numbered contacts.

KEY FINDING

30 + 26

acoustic contacts and magnetic anomalies, clustering at the terminal jetty and the Lekki-Ikoyi approach

- Coincident targets on the southern bridge approach are interpreted as ferrous structural remains in 5–7 m of water
- Uncertainty of 3–5 m horizontally and 0.46 m vertically meets Order 1a a priori; coverage and feature detection do not

DISCUSSION

Navigation Risk: The Highest Risks Are Not Bathymetric

A Intolerable

- Vessel collision in the confined terminal approach (RI = 9)
- Human factors: crew competence and compliance (RI = 9)
- Both arise from traffic convergence, not from a lack of depth

B Upper ALARP

- Grounding on margin shoals and contact with submerged obstructions (RI = 8)
- Insufficient under-keel clearance at constrictions, and bridge strike (RI = 8)
- Floating debris and water hyacinth (RI = 8)

RISK CONTROL OPTIONS

Low-cost operational controls at the bridges and the terminal, with crew competence and compliance, rank above channel marking, obstruction verification and a datum-connected tide gauge. Maintenance dredging ranks last: the central channel is maintained by the tidal flow itself.

Conclusions and Recommendations

C Conclusions

1. A continuous channel of at least 7 m runs along the thalweg; 0.17 km² of margin is shallower than 2 m
2. The products meet S-44 Order 1a uncertainty a priori (3–5 m horizontal, 0.46 m vertical) but not its coverage conditions
3. Collision in the terminal approach and human factors are the only intolerable risks

R Recommendations

1. Introduce a speed limit and one-way passage at the Lekki-Ikoyi span and the terminal approach
2. Mark the 2 m contour, verify the coincident targets and install a datum-connected tide gauge
3. Run cross-lines, verify both side scan channels and record currents over a spring–neap cycle

References

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Thank You

Questions and discussion

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