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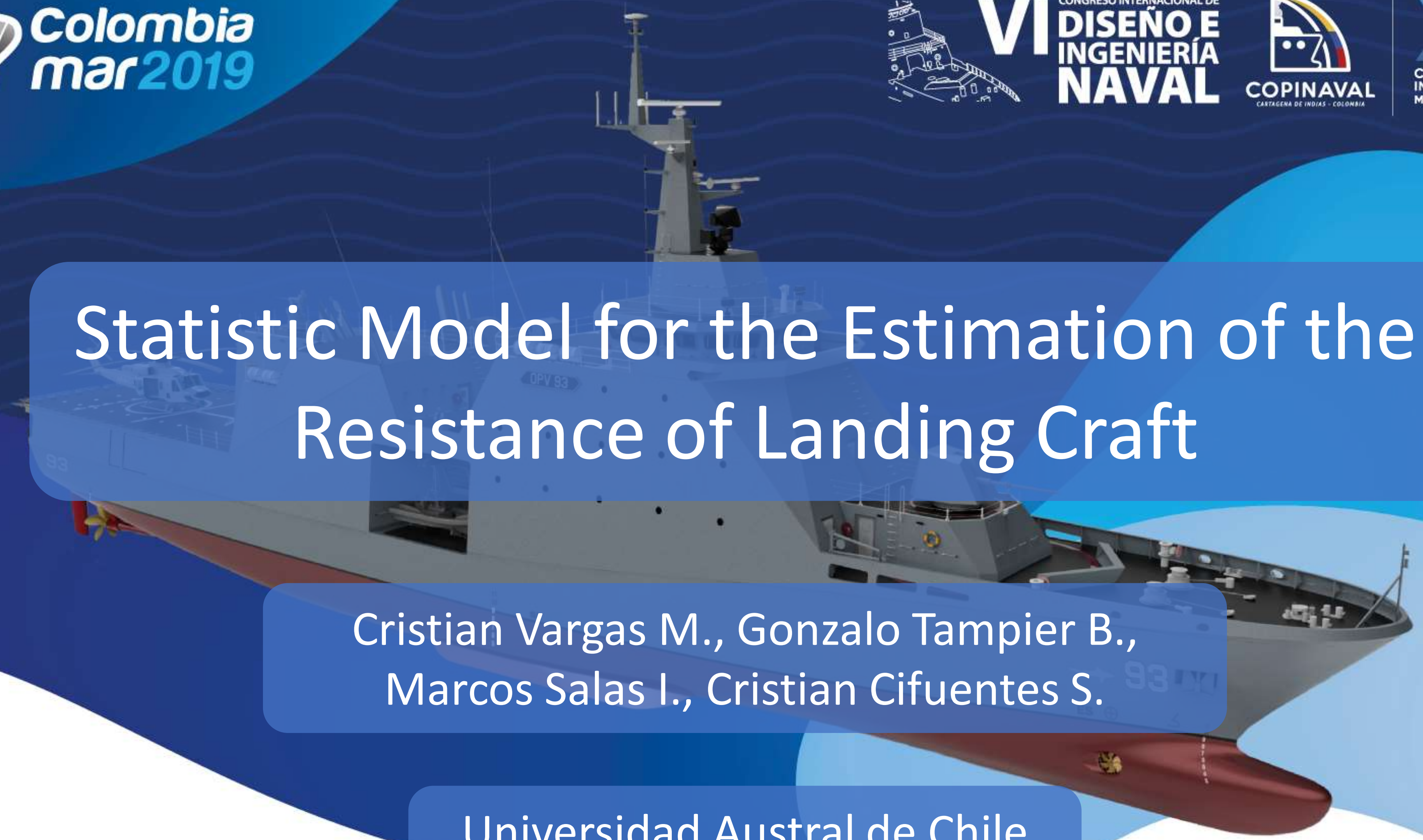

Statistic Model for the Estimation of the Resistance of Landing Craft

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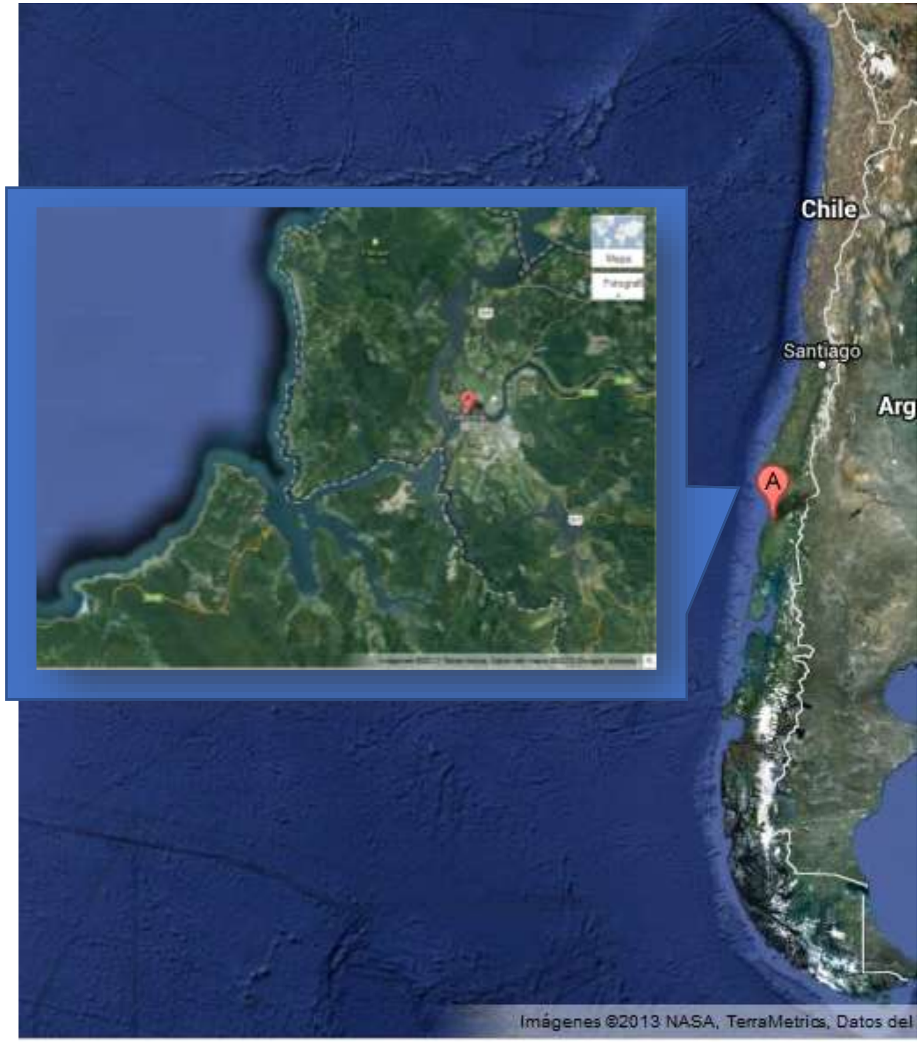


About us:

Universidad Austral de Chile (UACh)

- >15k students
- >50 degree programs, >30 postgraduate programs

LIBERTAS CAPITUR
UNIVERSIDAD AUSTRAL DE CHILE

About us:

Canal de Ensayos Hidrodinámicos(CEH-UACh)
Institute of Naval & Maritime Sciences

- One of a kind in Chile
- ITTC Member
- 45 x 3 x 2m
- Towing carriage for measurement systems
- Regular waves (upgrade to irregular undergoing)
- CNC router

Introduction

- Importance of estimation of ship resistance in early project stages
- Limited information for Landing Craft and Barge-shaped hulls
- Analysis from resistance tests from CEH-UACh to propose a simple estimation method for initial project stages

Landing Craft

- Main feature: ability to land on beaches using a lowerable ramp
- First exemplars for military use
- Large stability, large deck area, and low draft provide operational advantages, despite less optimal hydrodynamic performance

Landing Craft for comercial applications

Example in Chile: use as multi-purpose vessel for many different tasks, especially (but not limited to) salmon farming activities in sheltered channels and fjords.

Landing Craft for comercial applications

Landing Craft for comercial applications

Resistance tests are part of the design process, even for small sized barges due to high fuel prices and competitiveness.

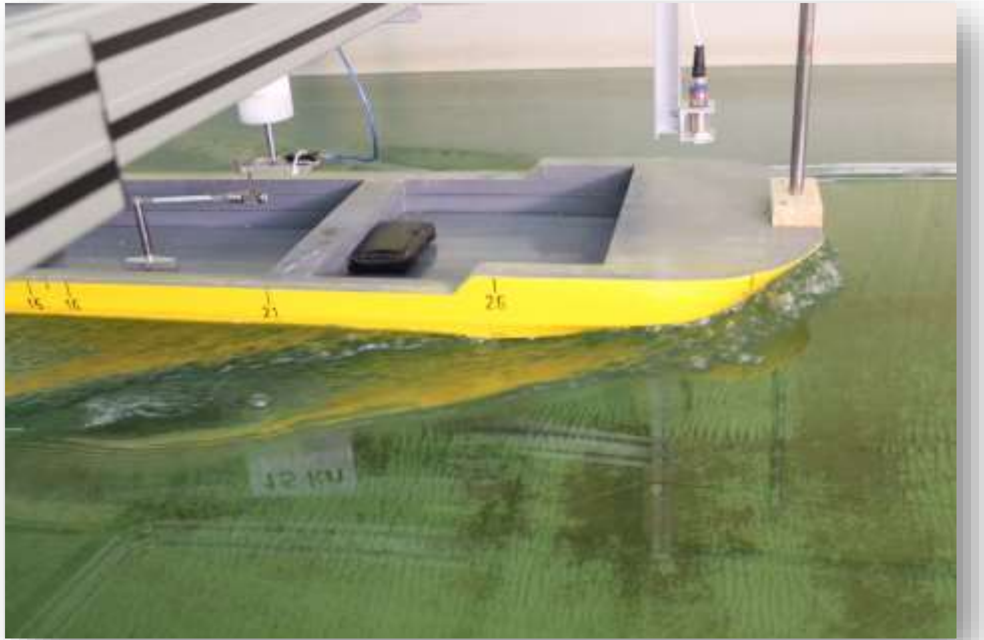
Database and Regression Process

- Database from 520 CEH-UACh tank tests, made between 1990 and 2016
- One part from early systematic series
- Another part from Landing Craft projects from industry

Description	L_{WL} (m)	B_{WL} (m)	T (m)	C_B	S (m2)	Δ(t)	∇(m3)	V_S (m/s)
Minimum	14,080	2,400	0,260	0,472	46,000	15,990	15,600	0,000
Maximum	20,000	12,000	1,900	0,840	322,400	322,834	314,960	7,155
1st Quartile	16,150	4,000	0,700	0,737	84,840	39,379	38,419	2,236
Median	17,000	5,000	1,060	0,771	107,600	66,152	64,538	3,578
3rd Quartilel	18,720	5,000	1,360	0,805	129,280	93,683	91,398	4,472
Mean	17,302	5,603	1,055	0,748	128,117	79,053	77,125	3,304
Variance (n-1)	3,081	10,032	0,162	0,008	4878,577	4170,302	3969,354	2,971
Typical deviation (n-1)	1,755	3,167	0,403	0,087	69,847	64,578	63,003	1,724

Database and Regression Process

- Multiple linear regression
- Data was analyzed and filtered: $0.22 \leq F_N \leq 0.4$ and $L/\nabla^{1/3} < 6$
- Seven independent variables:
  - Froude Number F_N
  - Slenderness coefficient $L/\nabla^{1/3}$
  - Block coefficient C_B
  - Main section coefficient C_M
  - Length to breadth ratio L/B
  - Length to draft ratio L/T
  - Breadth to draft ratio B/T



Database and Regression Process

Resistance estimation:

- $C_T = C_R + C_F + C_{AA} + C_A$

Residual resistance:

- $C_R = 0{,}060119 - 0{,}054478\, C_B + 0{,}026896 C_M - 0{,}017670\, {}^{L}/_{\nabla^{1/3}} + 0{,}004886\, {}^{L_{WL}}/_{B} + 0{,}001687\, {}^{L_{WL}}/_{T} - 0{,}0016367\, {}^{B}/_{T} + 0{,}101304 {F_N}^2$

Friction resistance:

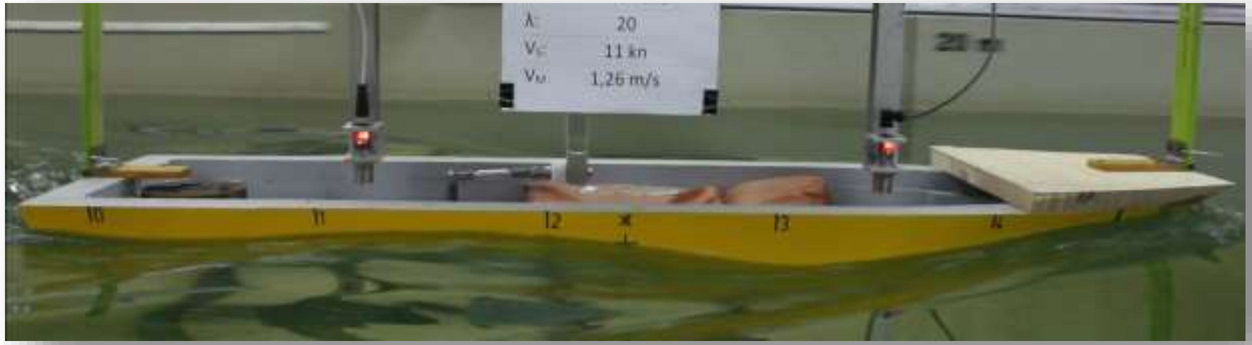
- $C_F = \frac{0{,}075}{(\log(R_n) - 2)^2}$

Air resistance:

- $C_{AA} = 0{,}001\, {}^{A_T}/_{S}$

Correlation allowance:

- $C_A = 0{,}105 \left({}^{k_S}/_{L}\right)^{1/3} - 0{,}00064$



(Appendages, added resistance in waves and other effects can be added if required)

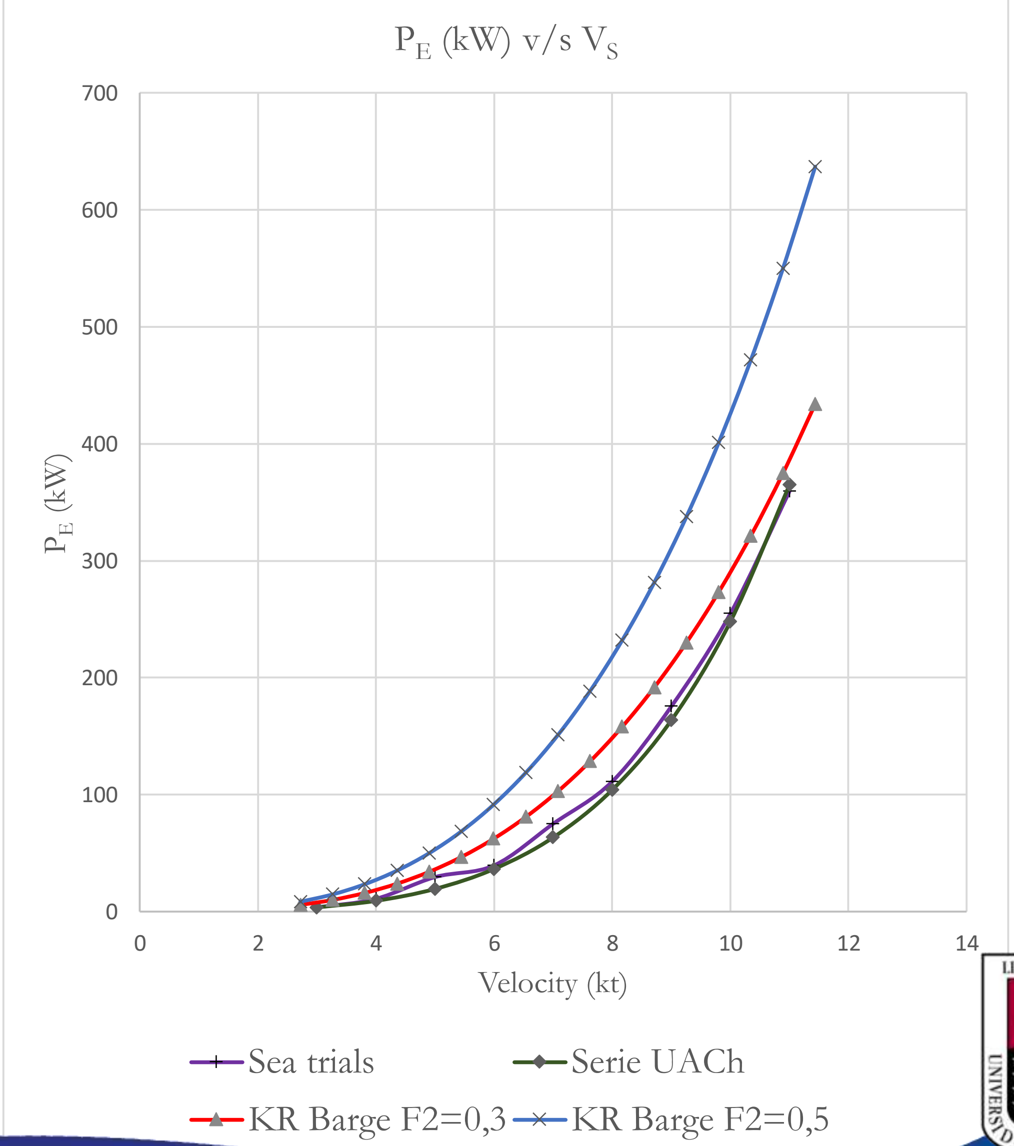
Determination of Model Efectiveness

- Comparison of sea trials, KR (Korean Register) method and proposed method

	ISLA PICTON
L_{wl}	20,586 m
B_{wl}	6,22 m
T	1,03 m
∇	109,7 m^3
C_B	0,659
L_{wl}/B_{wl}	3,3
L_{wl}/T	19,98
B_{wl}/T	6,039
$L_{WL}/\nabla^{1/3}$	4,3
P_B	240 HP x 2

Determination of Model Efectiveness

- Results show good agreement with data from sea trials
- Large uncertainty from KR method bow shape factor F2 makes a comparison difficult
- More validation is necessary



Conclusions

- A new landing craft resistance estimation method has been proposed, useful for typical shapes of small commercial landing craft
- The method can be improved by including more hull shape parameters and a deeper validation for more application cases
- Nevertheless, results can be considered encouraging and useful for early design stages
- Under no circunstances, these results should be considered as a replacement or tank tests or numerical simulations

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