THE UNIVERSITY OF CHICAGO

MACS 32000 (Winter 2026) Computational Research Design

Professor J. Clipperton

Maritime Security as a Global Public Good: Trade Frictions, Chokepoint Vulnerability, and aScenario Engine Using AIS Shipping Density

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This is the preliminary presentation template for Carlos Carpi's final project

Presentation Outline

1. Introduction
2. Literature & Methods
    1. Review of Literature
    2. Data Description
    3. Methods
3. Scenarios & Preliminary Results
4. Conclusion
    1. Limitations
    2. Quantified Hegemonic Dividends
    3. Takeaway

Introduction

Motivation: Valuing Economic Security

- ~80% of world trade by volume traverses the oceans (Verschuur et al., 2023)
- Trade funnels through a small number of physical bottlenecks: straits, canals, narrow sealanes
- When security breaks down⇒rerouting, congestion, elevated trade costs
- The U.S. Navy provides security at these chokepoints as aglobal public good(Buegeret al., 2024)
- **<u>Key question</u>**:
  - What is the economic value of this security provision?

Literature & Methods

LITERATURE

LIT(I): Maritime Security as a Public Good

- **Maritime security** exhibits classic public-good properties: **non-rivalry** and **partial non-excludability**
- Legal foundations: freedom of navigation, passage through straits.
- Economic costs of insecurity documented:
  - Piracy: ransoms, insurance, rerouting, deterred investment (One Earth Future Foundation, 2010)
  - African development impacts (Mbekeani and Ncube, 2011)
- Gap: the value of security provision remains poorly quantified

For maritime security, see (Bueger et al., 2019, 2024)
For legal framework see (Kraska, 2015)

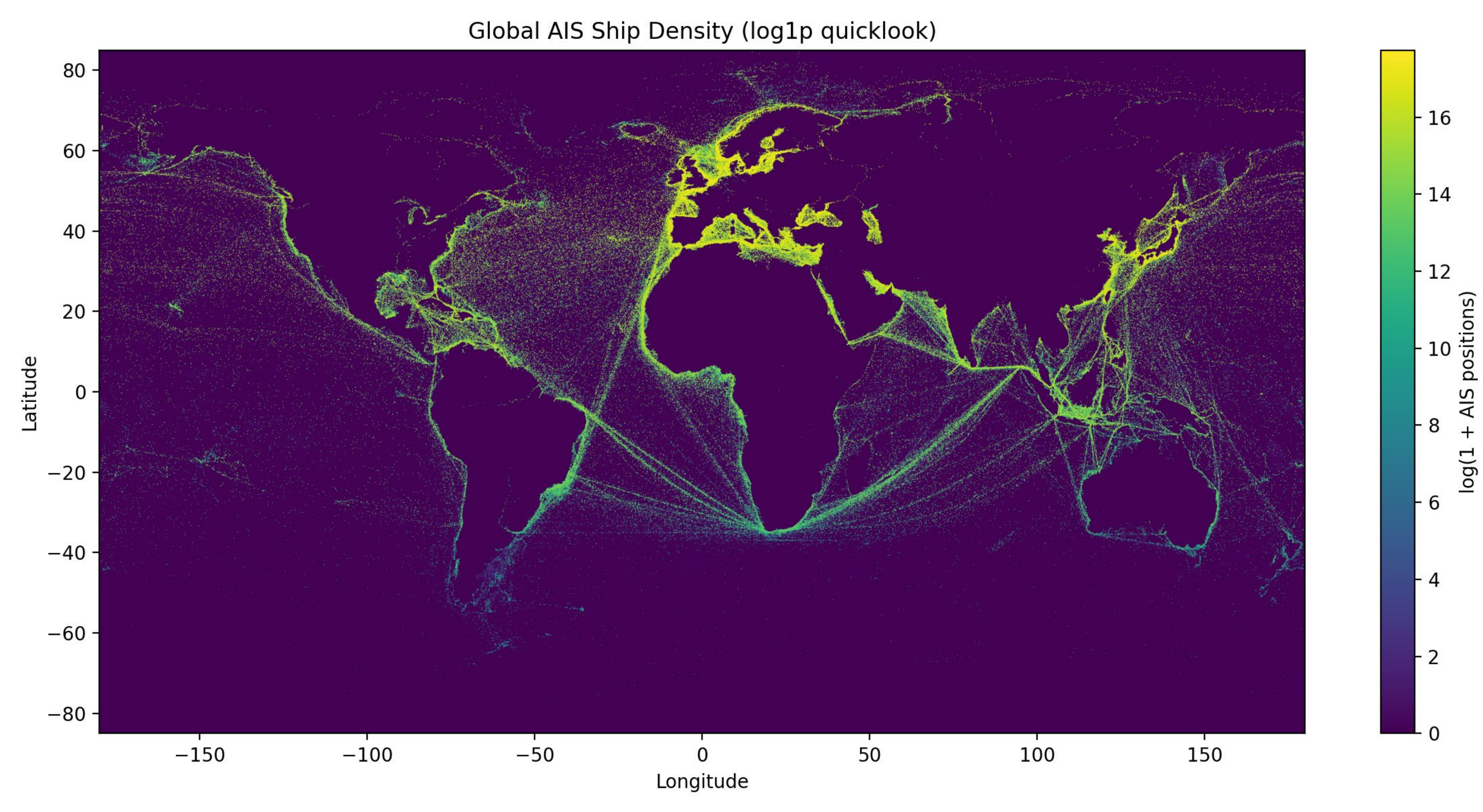
LIT(II): AIS Data & Research Gap

- AIS data: cornerstone of modern maritime economics (Kerbl, 2022)
- COVID shock on container flows: Cariou and Cheaitou (2021)
- Nowcasting world trade from AIS: Cerdeiro and Komaromi (2020)
- IMF World Seaborne Trade Monitoring System: Cerdeiro et al. (2020)

No existing work combines a global maritime network model with **endogenous rerouting** & c**ongestion** to value security provision under counterfactual disruptions

DATA

Ship Density (2015-21)



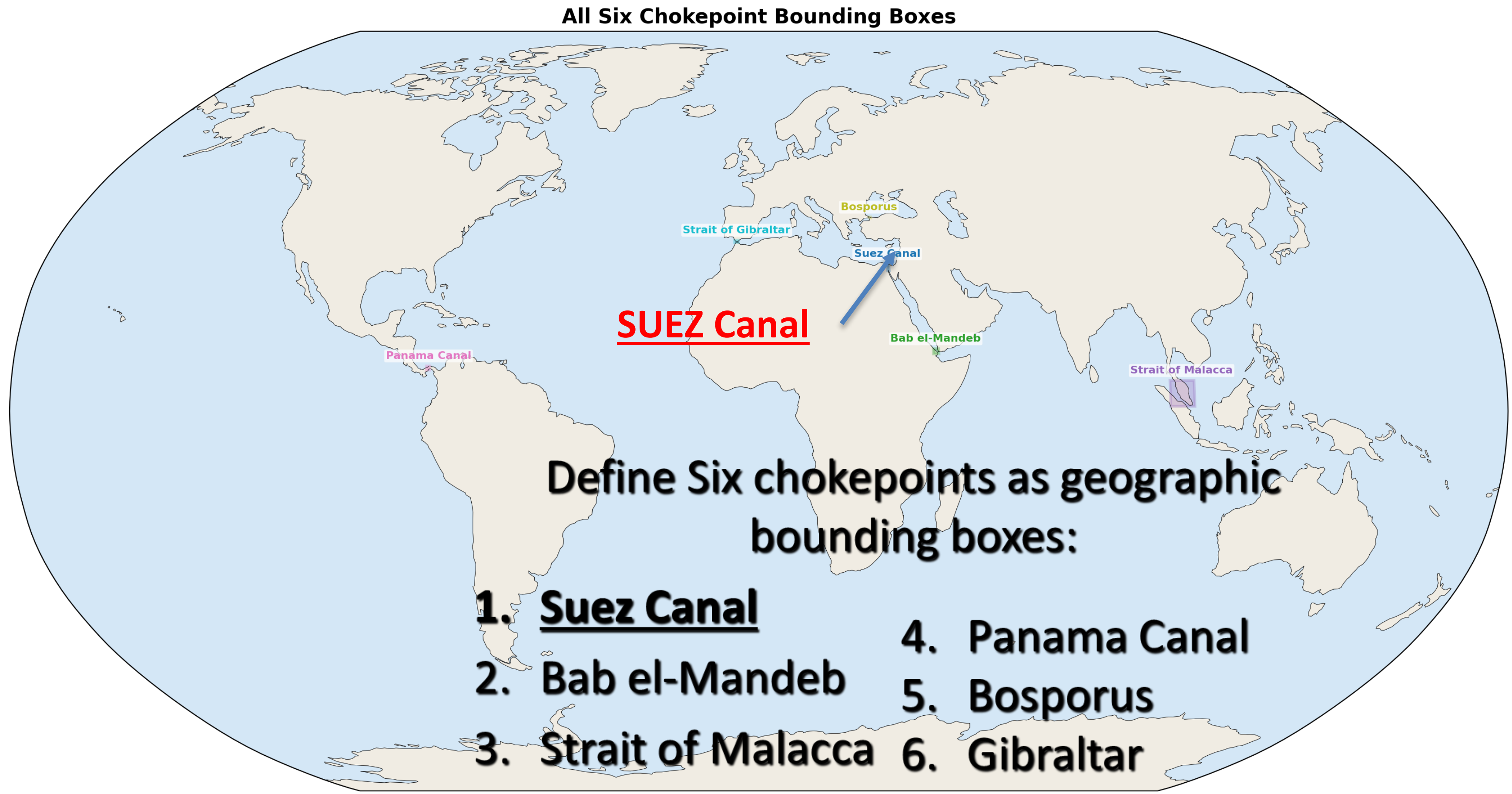
Cerdeiro et al., 2020

WB-IMF World Seaborne Trade Monitoring System (Cerdeiro et al., 2020)

- Data: AIS Ship Density Raster
- System Period: January 2015 – February 2021
- Resolution: 0.005∘×0.005∘(≈500m×500m at equator)
- Each cell: total count of AIS position reports
- Format: GeoTIFF (~9 GB) + pyramids (~3 GB)
- Processing: overviews for visualization, windowed reads for chokepoints

METHODS

Use Ship Density & create 6 boxes

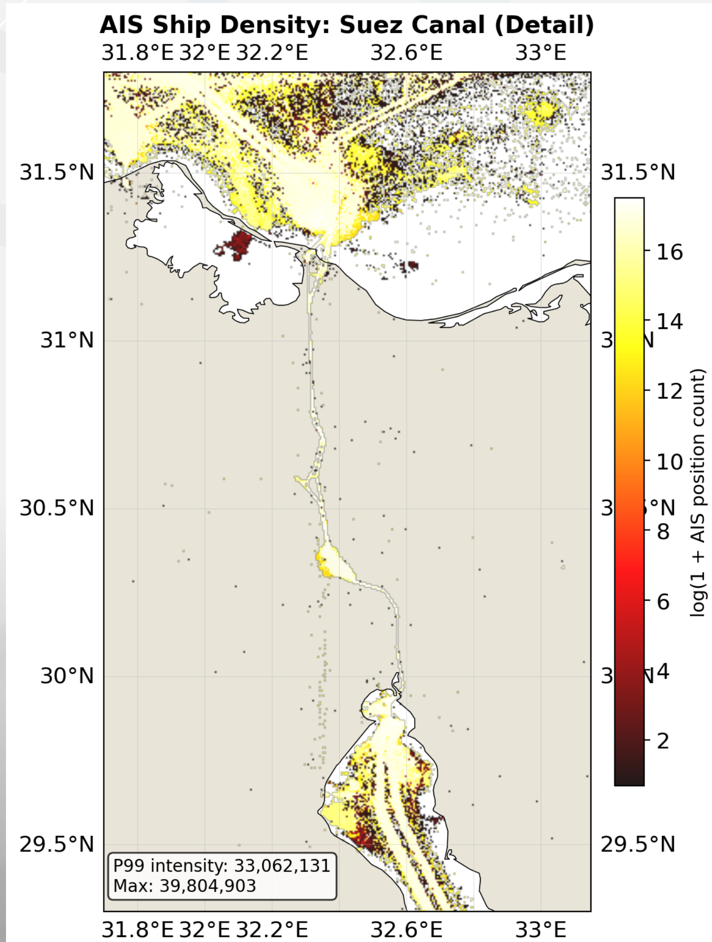


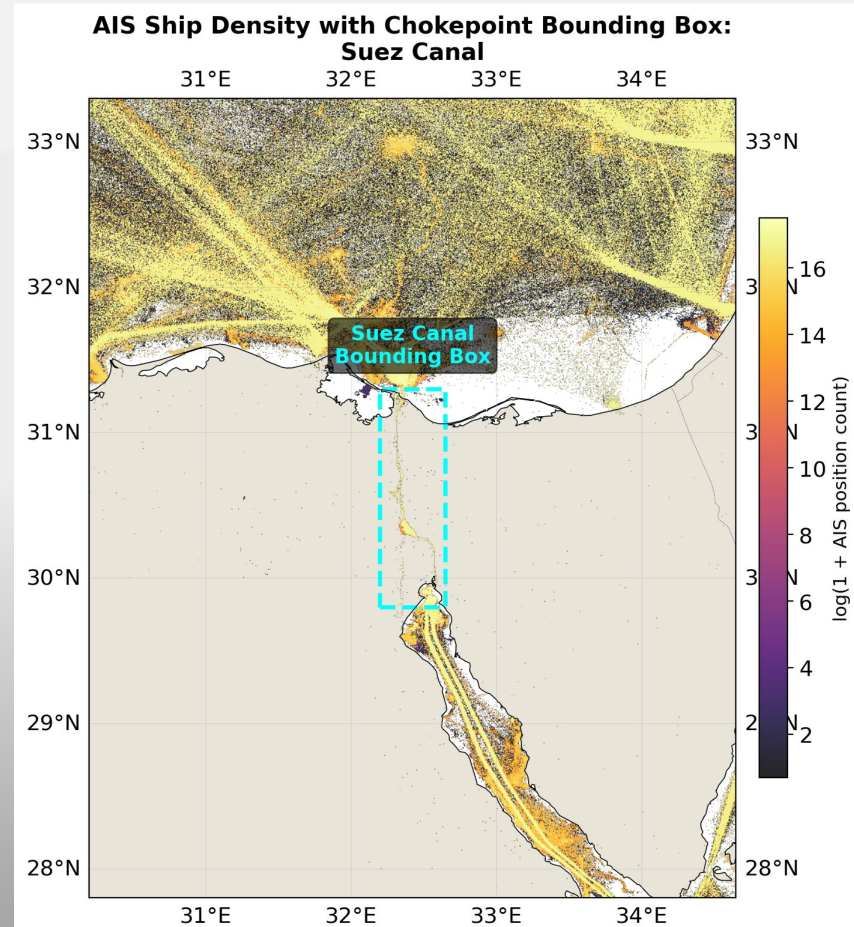
Define Six chokepoints as geographic bounding boxes:

1. **Suez Canal**
2. Bab el-Mandeb
3. Strait of Malacca
4. Panama Canal
5. Bosporus
6. Gibraltar

Cerdeiro et al., 2020

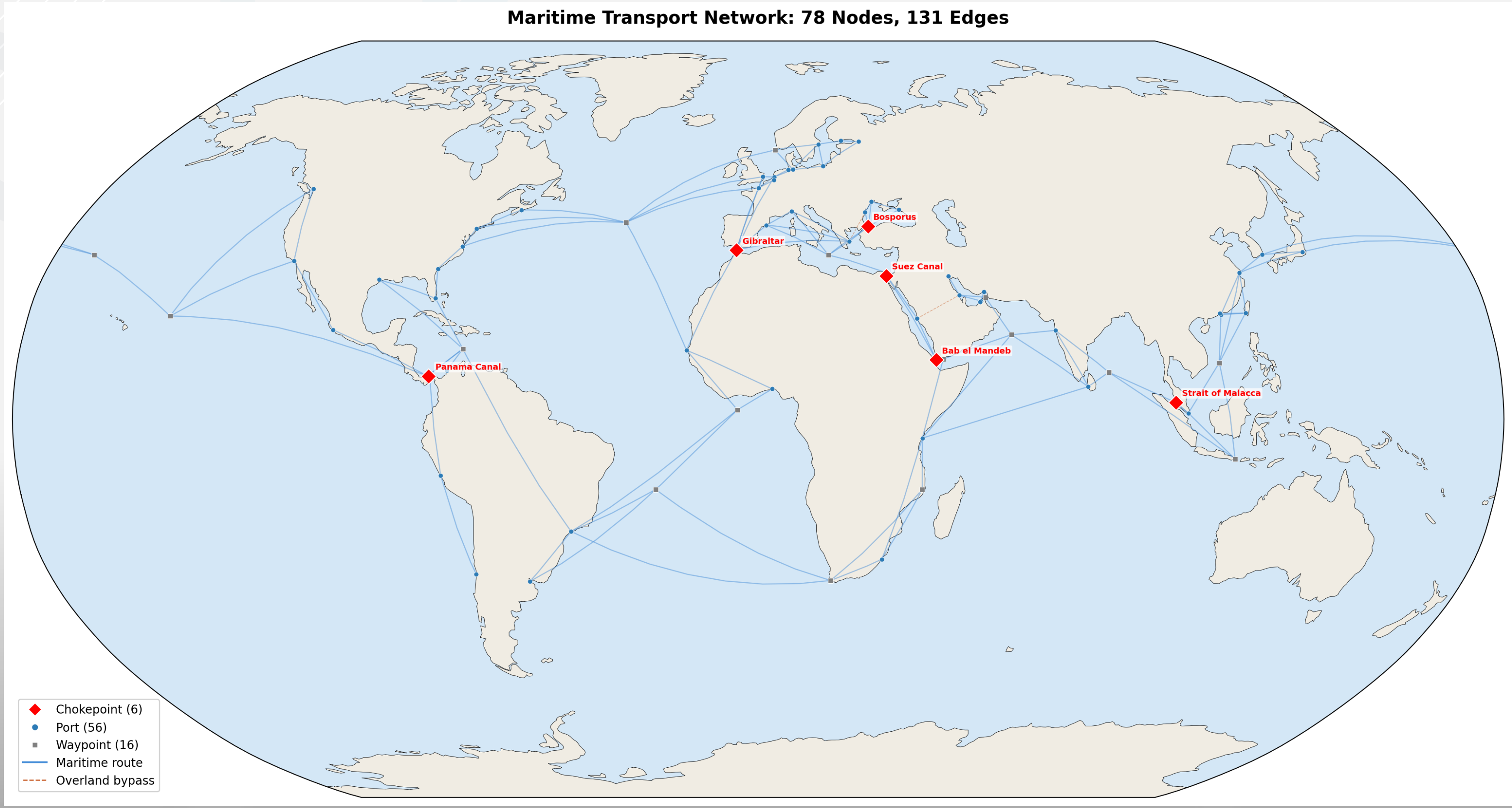
Bounding Box Approach: Suez Canal



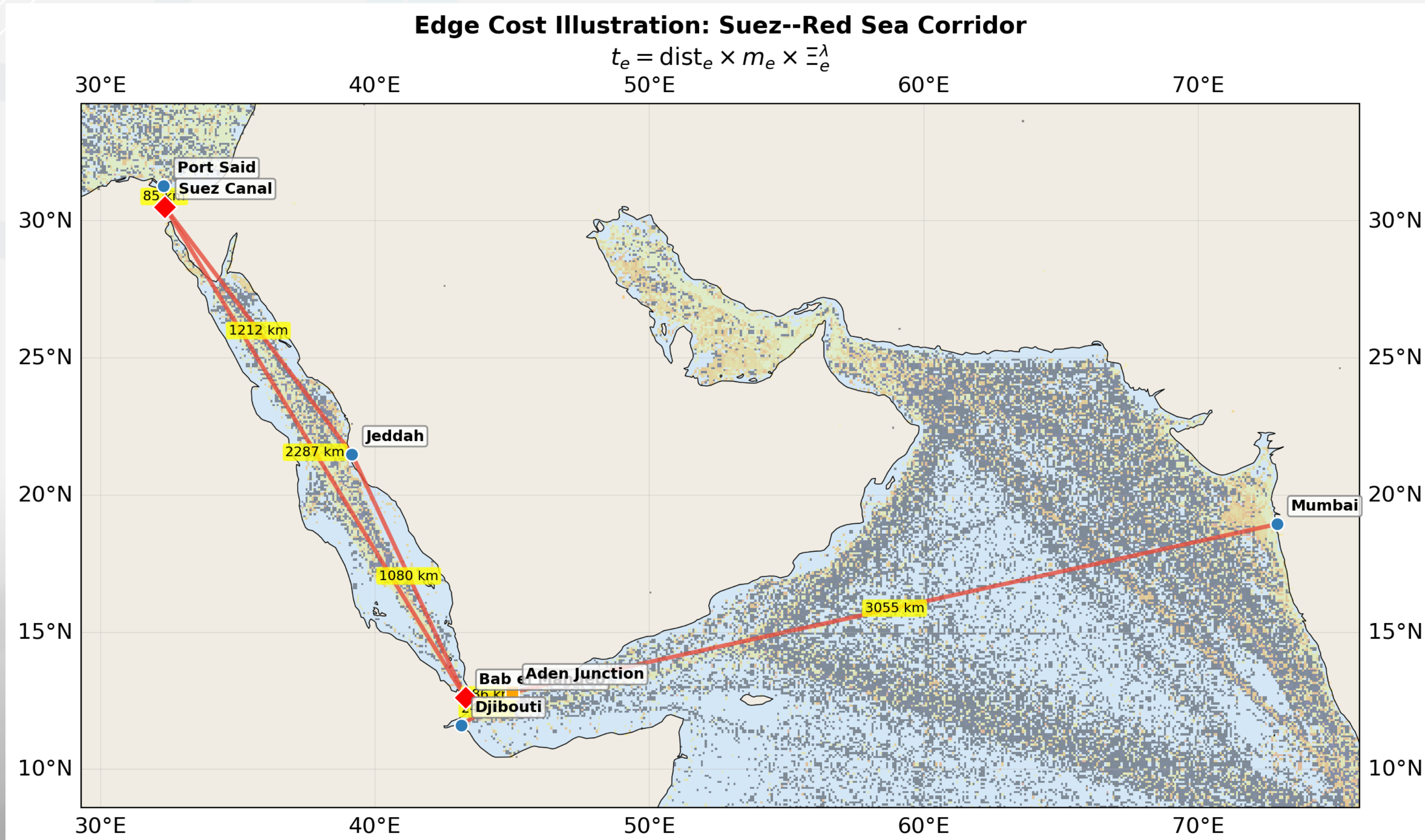


Selected per Verschuur et al. (2023); Buegeret al. (2024

Network: 78 Nodes, 131 Edges

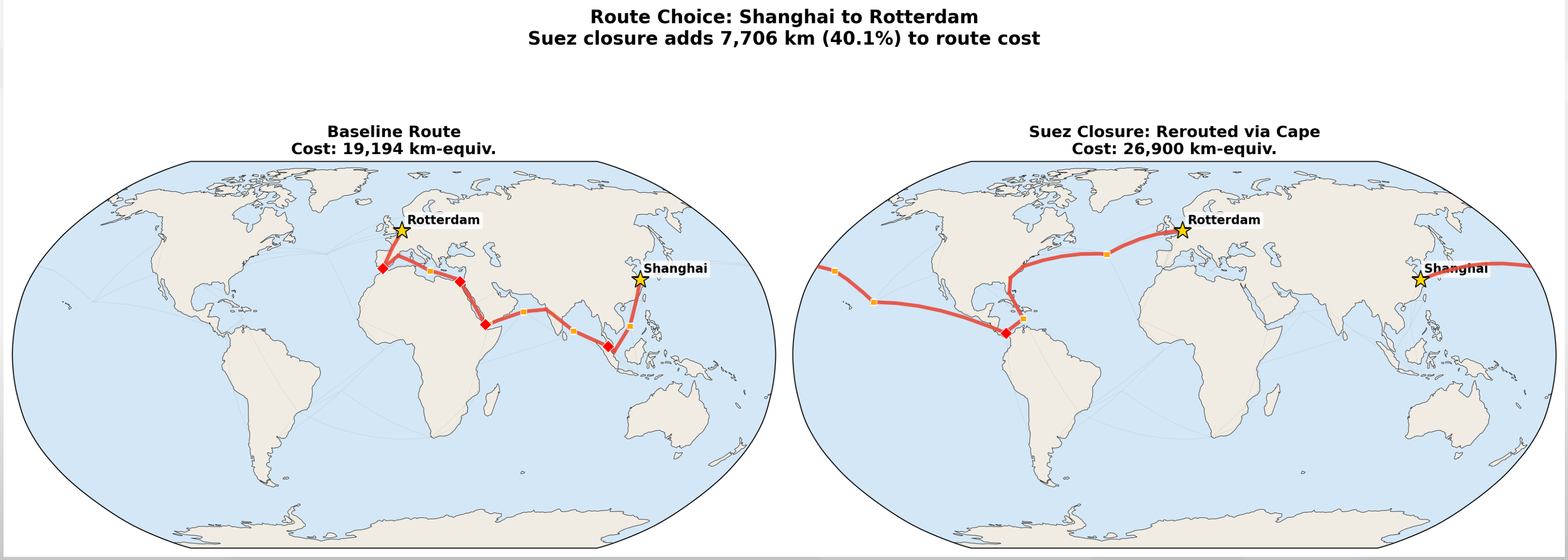


Zoomed in: Suez Canal Network



Scenarios & Results

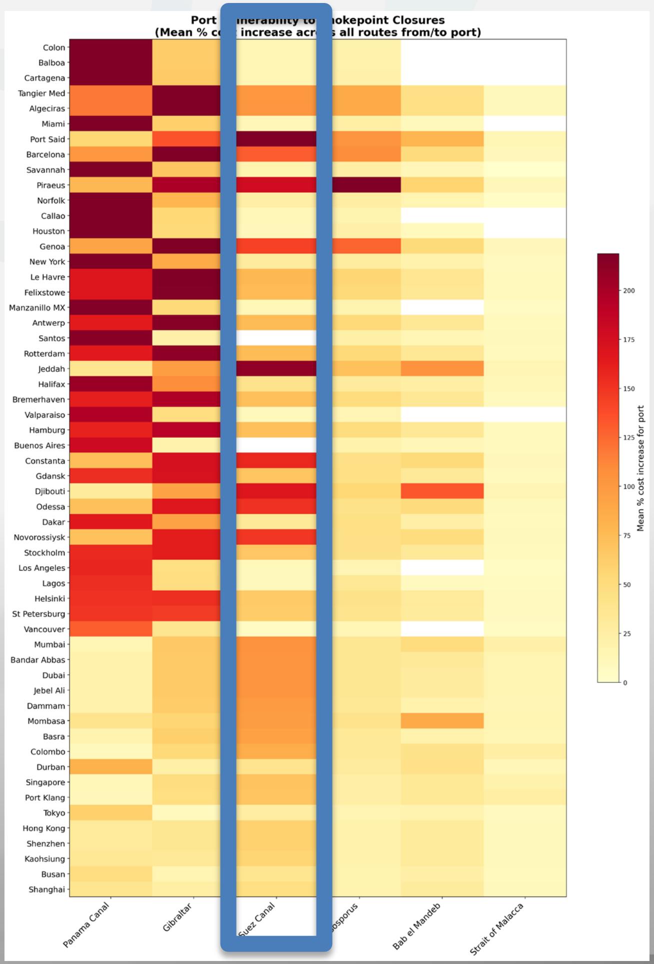
Closing Suez: What Happens?

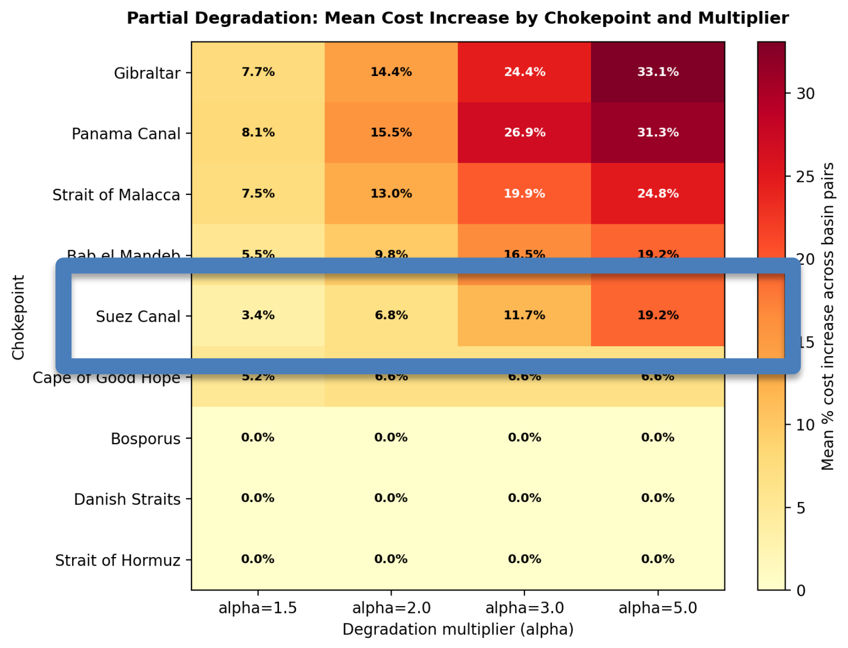


Re-Route Overview

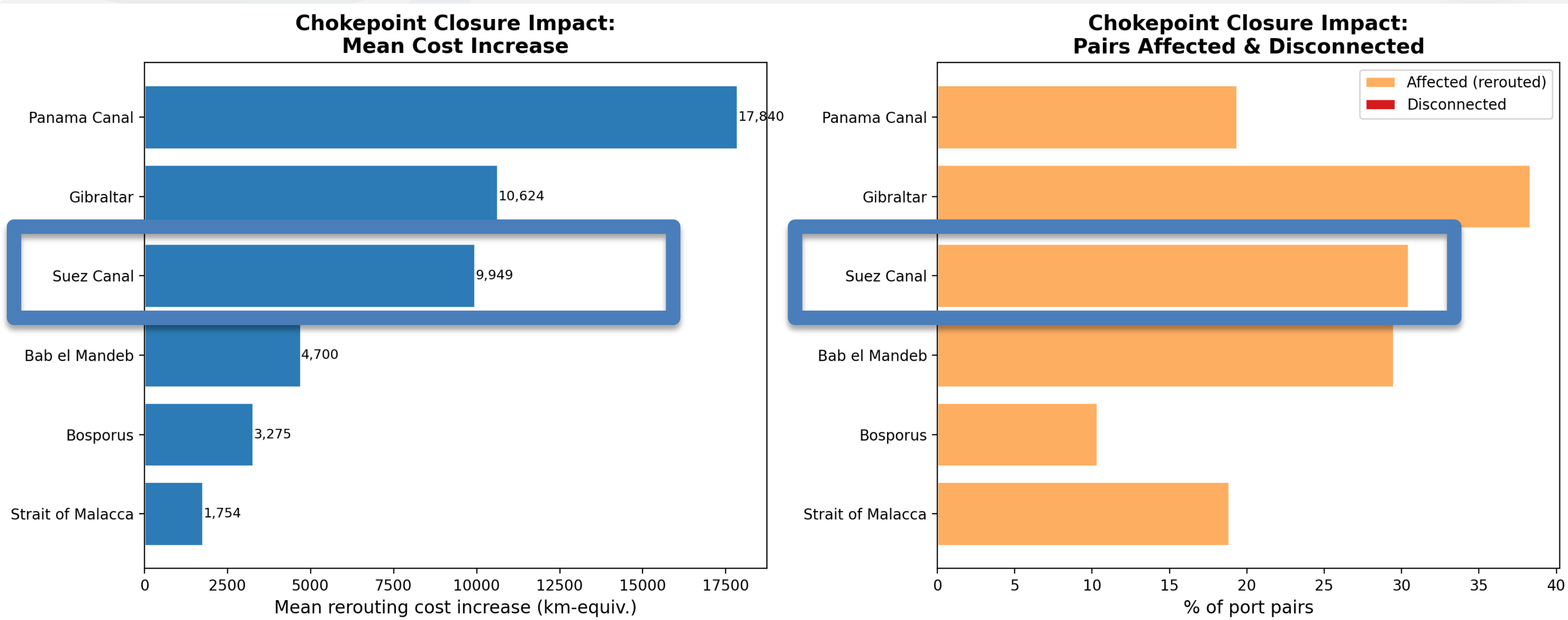
Chokepoint Removed	Mean Δ (km)	Affected	Disconn.	Total
Panama Canal	17,840	298	0	1,540
Gibraltar	10,624	590	0	1,540
Suez Canal	9,949	469	0	1,540
Bab el-Mandeb	4,700	454	0	1,540
Bosporus	3,275	159	0	1,540
Strait of Malacca	1,754	290	0	1,540

Full Closure Vs. Partial Degradation





Overview of Impacts:
Suez: ~10k Dist. & 30% of Ports



Cost Estimates per Chockepoints

Chokepoint	Daily Vessels	Detour (km)	Cost/Day (Low)	Cost/Day (High)
Gibraltar	219	10,624	\$116M	\$233M
Panama	37	17,840	\$33M	\$66M
Suez Canal	53	9,949	\$27M	\$53M
Malacca	233	1,754	\$20M	\$41M
Bosporus	118	3,275	\$19M	\$39M
Bab el-Mandeb	68	4,700	\$16M	\$32M

Low = \$50/km; High = \$100/km. Aggregate: \$230–460M/day across all chokepoints.

Conclusion

Limitations

I. Static aggregate: single 2015–2021 snapshot; no temporal dynamics
II. Aggregate density: AIS counts, not shipped value; no vessel-type distinction (Kerbl,2022)
III. No welfare computation: delta costs, not GE welfare changes (Redding and Rossi-Hansberg, 2017)
IV. Exogenous security: risk premiums are sensitivity inputs, not calibrated
V. Stylized network: 78 nodes captures major routes but not all alternatives
VI. All results labeled as "partial-exercise" estimates

Hegemonic Dividend Quantified

- Daily costs: Gibraltar closure alone⇒
  - $117–233M/day in rerouting costs
- Aggregate: simultaneous closure of all six chokepoints⇒
  - $85–170B/year
- The “hegemonic dividend” = avoided cost from maintaining security
- Dividend is increasing in risk: value of security rises as conditions worsen
- Heterogeneous benefits: bypass-dependent ports (Black Sea) benefit most

(Bueger et al., 2024; Besley et al., 2015; One Earth Future Foundation, 2010)

Takeaways

- ✓ Chokepoint disruptions produce large, heterogeneous trade-cost impacts
  - ✓ Panama: 17,840 km mean rerouting; Suez: 9,949 km; Gibraltar: 10,624 km
- ✓ Two vulnerability types: rerouting(through-corridor) vs expensive bypass(bypass-dependent)3
- ✓ The hegemonic dividend is increasing in the risk environment
- ✓ Daily closure costs: **$16M–$233M/day** depending on chokepoint
- ✓ This is a replicable framework identifying data needs for full causal assessment

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ThanQ!

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Appendix