MARITIME PORT CONNECTIVITY NETWORK

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ES 404

1. Introduction

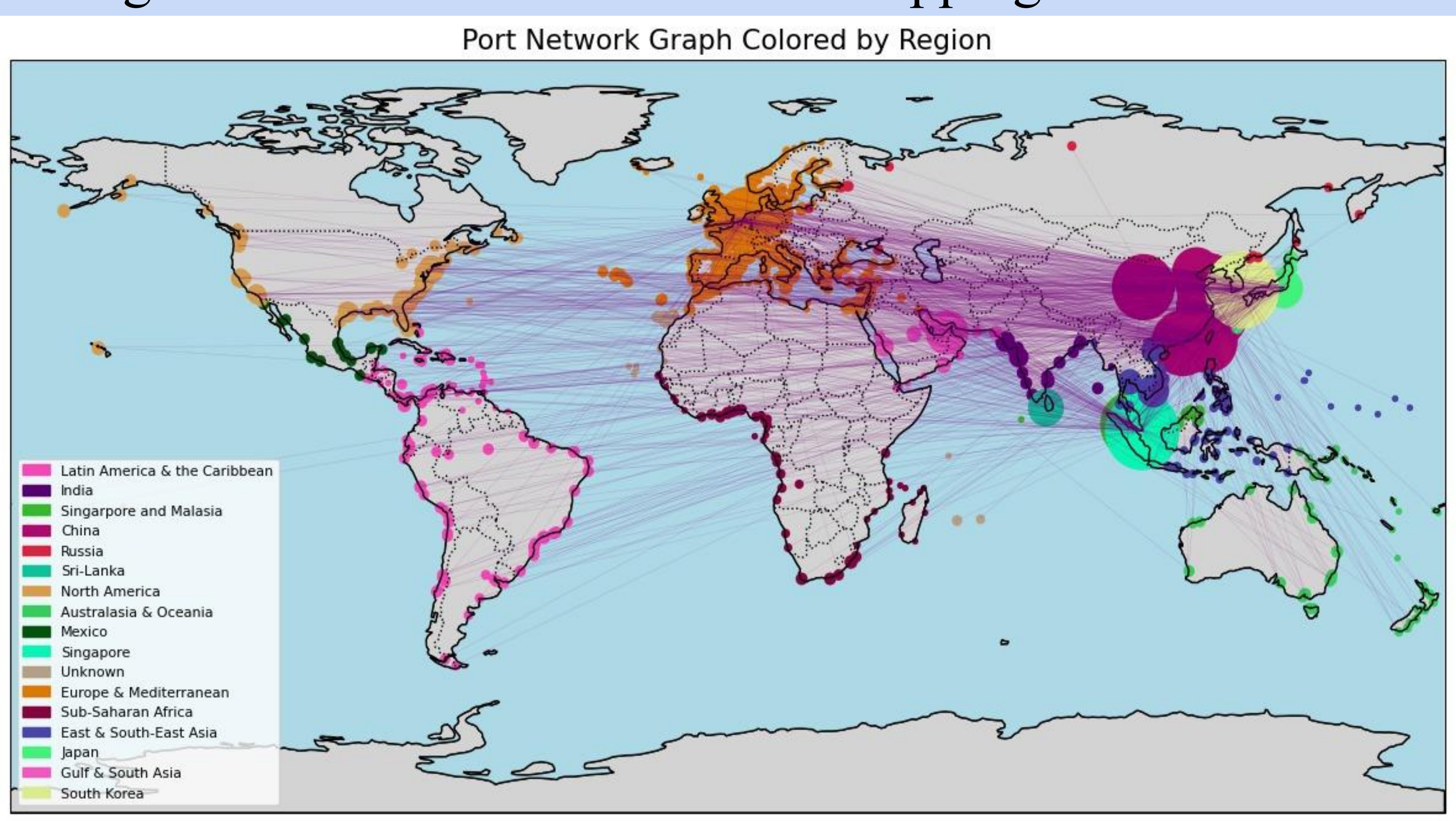
Maritime ports are the lifelines of international trade facilitating over 80% of global goods network. This project models the global shipping network as a graph, analyzes its structure, and evaluates its vulnerability, central hubs, and resilience using real-world data. Analyzing these networks can uncover their **strategic importance**, **vulnerability**, and potential for **adaptability**. Our Network has 908 nodes and 12479 Edges

2. Research Questions

- Why is **China** a dominant maritime hub? What if Chinese ports are disrupted or attacked?
- What strategic role does **Sri Lanka**'s port play in the network?
- Can the **structure of this network evolve** over time.

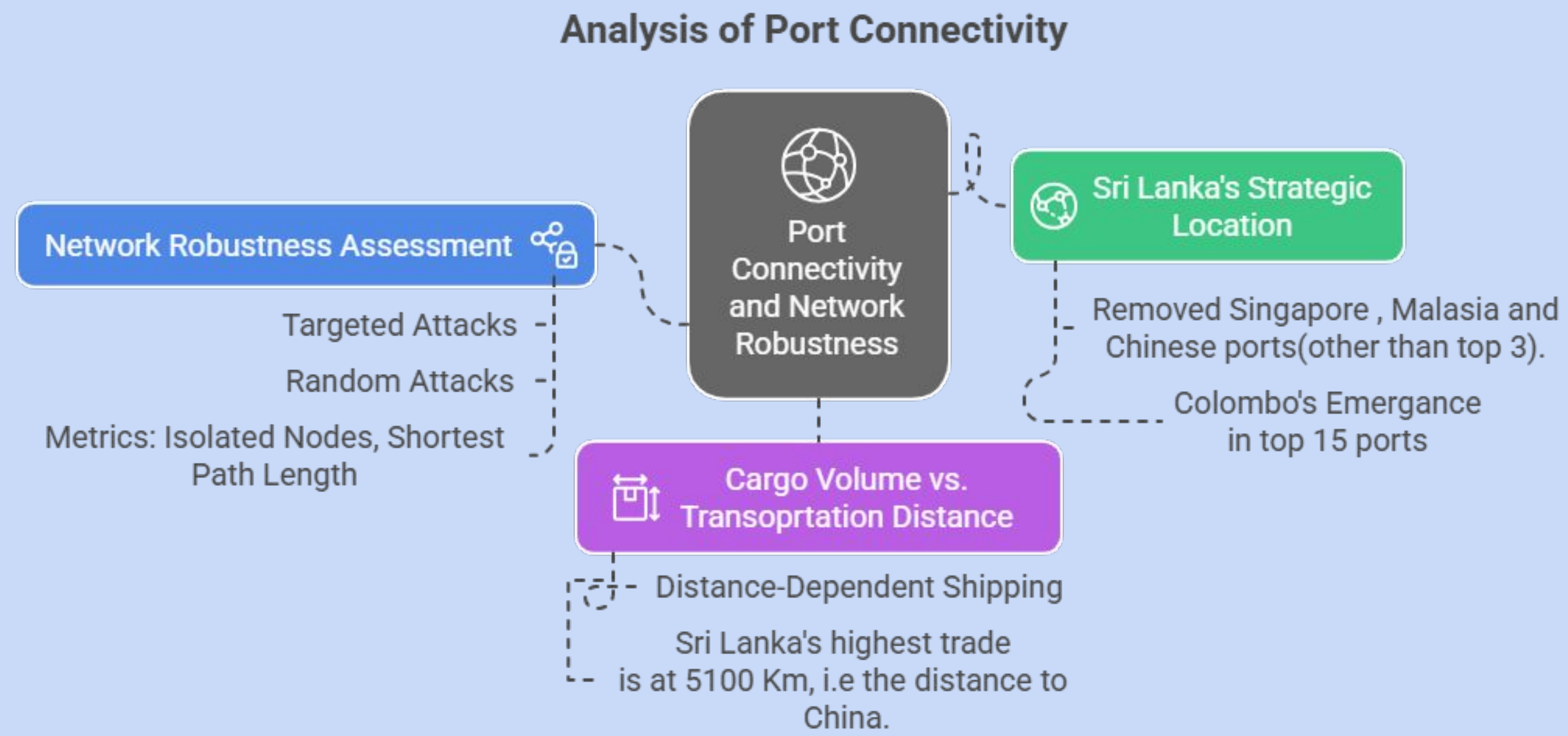
3. Datasets

- Nodes and edges derived from UNCTAD's **PLSCI** (port connectivity) and **LSBCI** (country-pair connectivity) datasets.
- Computed : **PLSBCI**(port linear shipping bilateral connectivity index) = $(PLSCI_A + PLSCI_B)/2 \times LSBCI_{A,B}$
- Filtered top 12,749 port pairs ($\approx 3.1\,\%$ of ${}^{908}C_2$) with highest PLSBCI to reflect actual shipping routes.

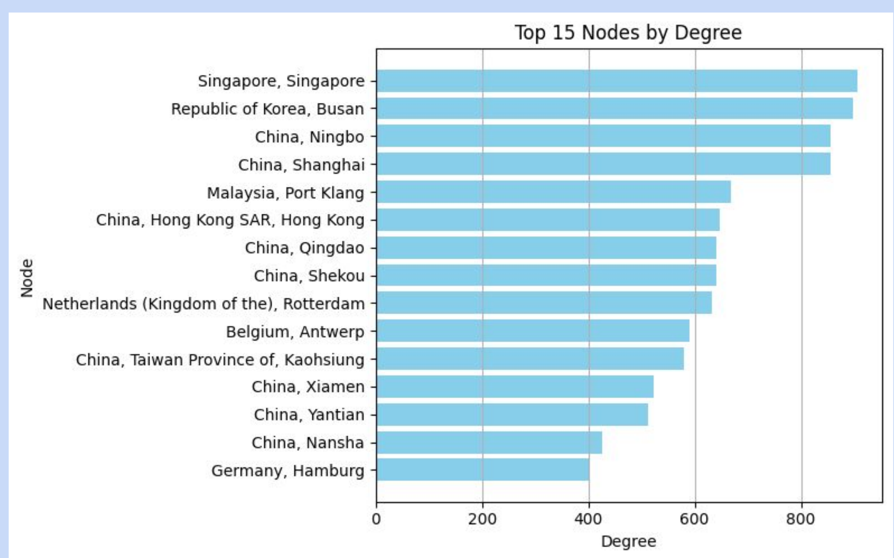


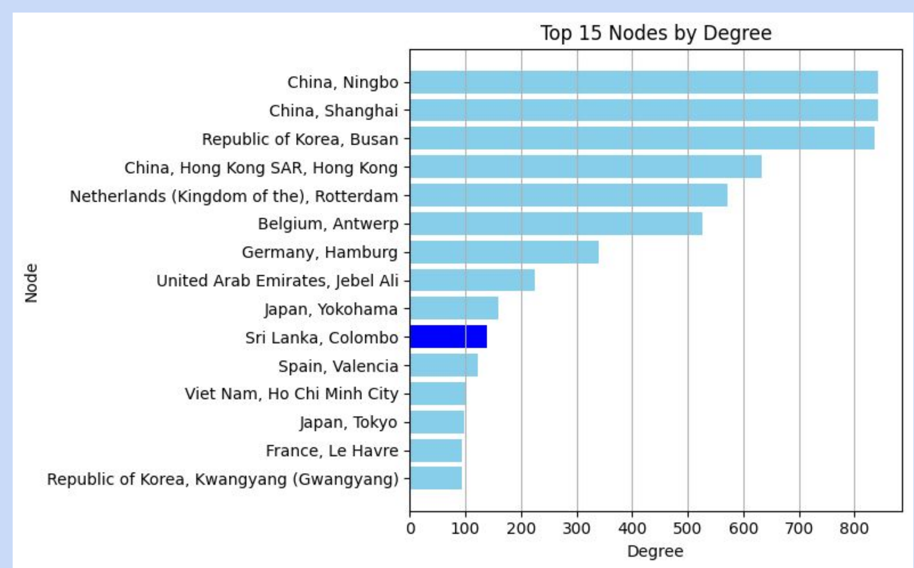
4. Methodology

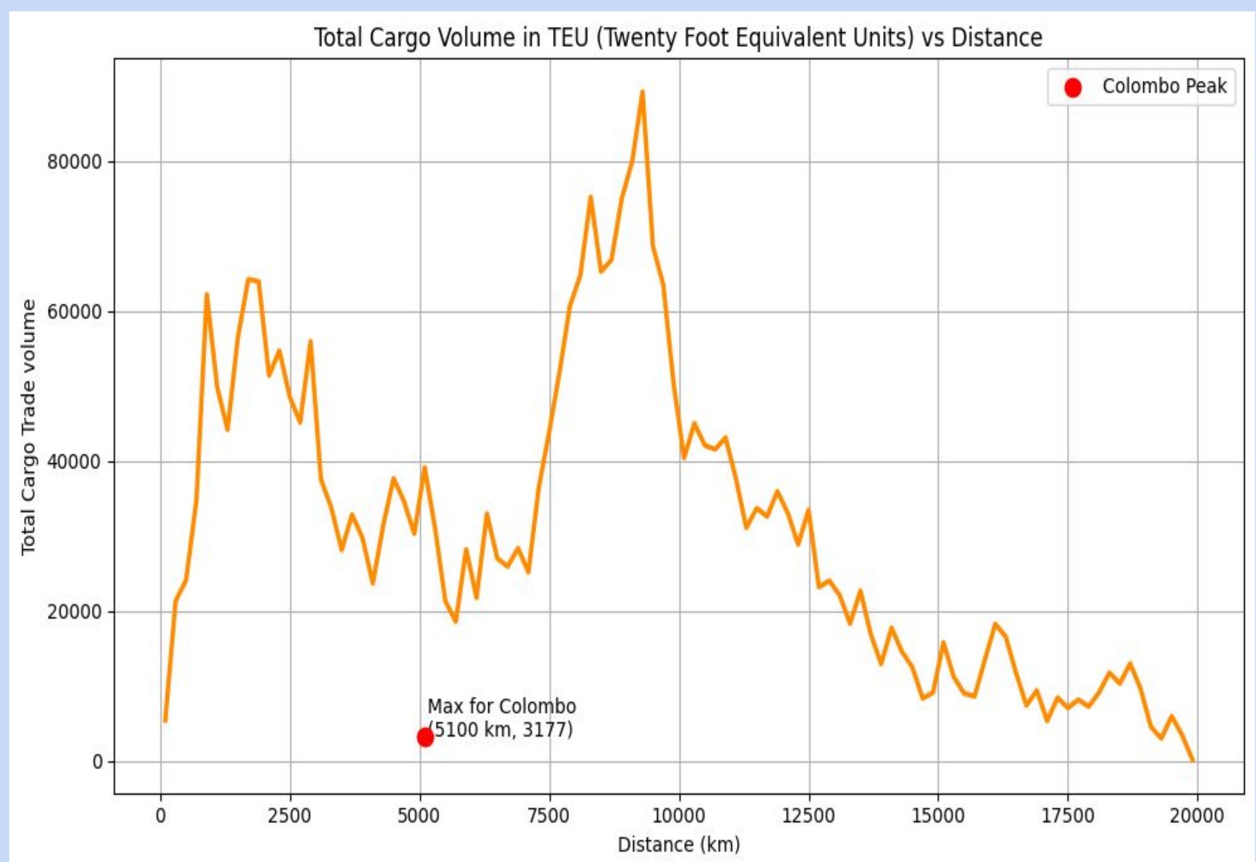
We analyzed port connectivity using degree centrality, simulating geopolitical tensions by removing key ports, which highlighted Colombo's rising importance. We also assessed network robustness through targeted and random port removals, tracking fragmentation and efficiency loss.



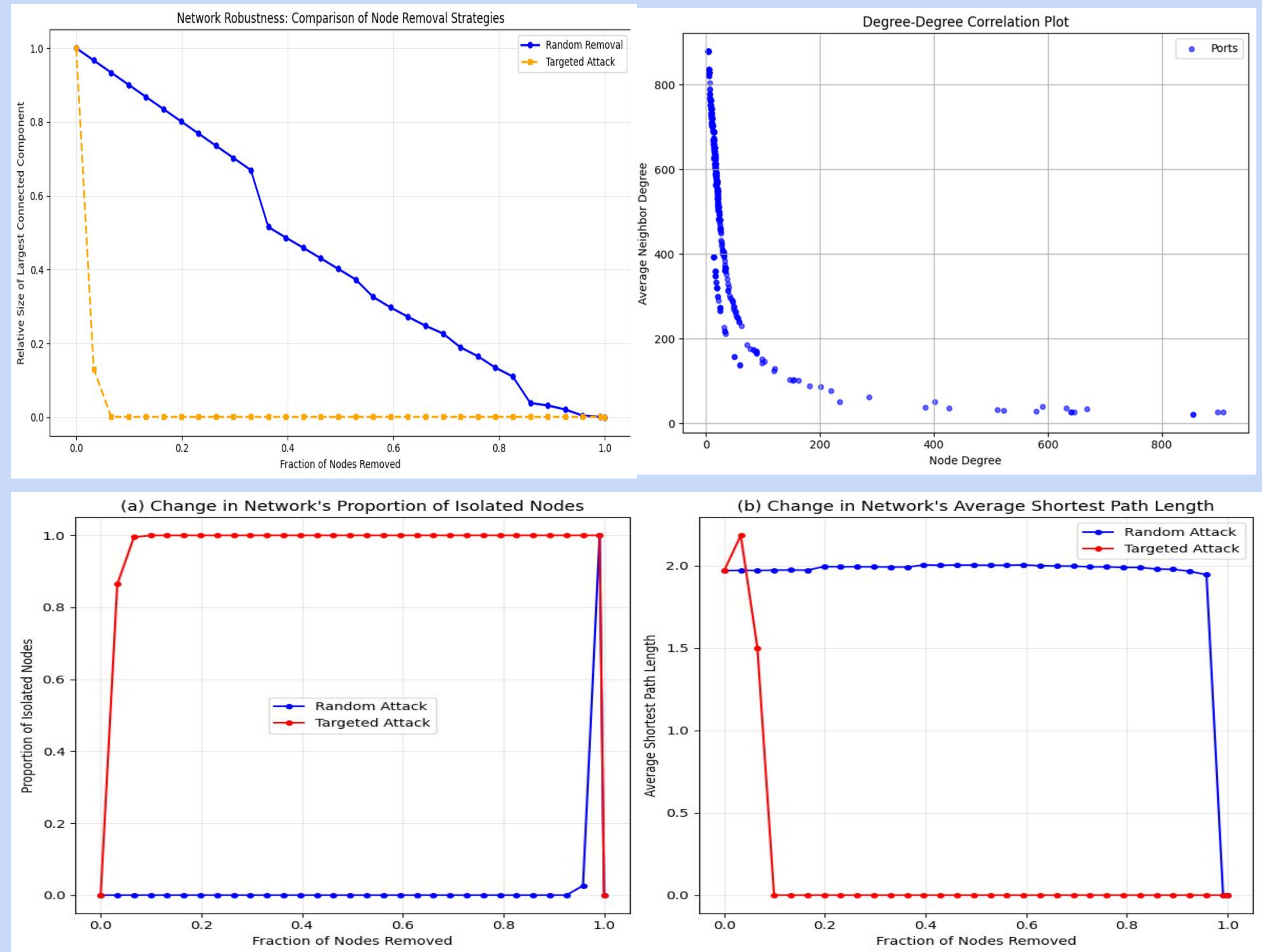
5. Results







Sri Lanka's peak cargo volume at 5100 km highlights its strong maritime trade dependence on China, with the Port of Colombo serving as a key hub in this vital trade route.



6. Conclusion

- The **Maritime Port Connectivity Network** follows a power-law distribution (**γ = 1.8395**),causing both **mean and variance to diverge** resulting in a **heavily right-skewed degree distribution**, where a few ports have disproportionately high connectivity;ports such as **Singapore**, which alone has a degree of **907**.
- **China's ports** play a crucial role in maritime trade we simulated a **targeted disruption of 90% of Chinese ports** revealed that **alternative ports**, such as **Colombo in Sri Lanka**, rise in relative importance—showing **latent strategic potential** in the regional network.
- This shift highlights the network's **hub-and-spoke topology**, further supported by the **strongly negative assortativity coefficient (-0.6889)**, where **high-degree hubs mostly connect to low-degree regional ports**.
- As a result, the network is **highly vulnerable to targeted attacks**, with our analysis showing a sharp **increase in isolated nodes** and a **decrease in overall efficiency** (as reflected in average shortest path length) compared to random failures.

7. References

1.https://unctadstat.unctad.org/datacentre/.
2.https://www.nature.com/articles/srep34217.
3.https://pmc.ncbi.nlm.nih.gov/articles/PMC2880080/.

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