

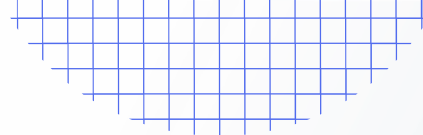


BADAN PUSAT STATISTIK



Regional Hub
On Big Data and
Data Science
for Asia and The Pacific

UNBigData



Utilization of AIS Data for Transportation Statistics & Greenhouse Gas Emissions

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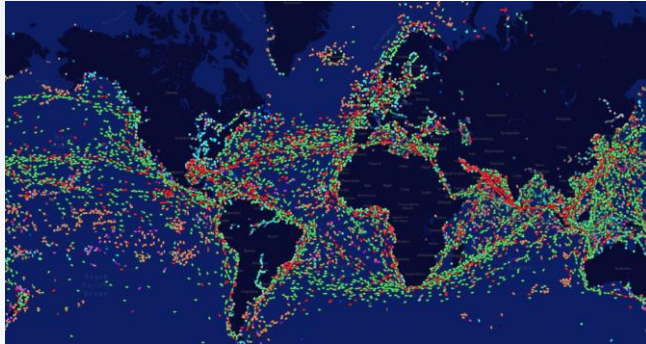
in collaboration with:

Dewi Krismawati (BPS), Markie Muryawan (UNSD),
Cherryl Mallari Chico (World Bank)

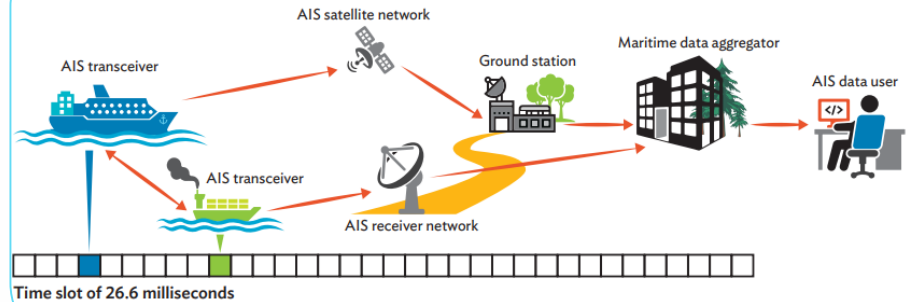
**Sprint on Artificial Intelligence and Data Science for
Economic Statistics**

AIS (Automatic Identification System)

Marine Traffic



AIS signal transmission flow



- ❑ **AIS:** tracking system with transponder *Very High Frequency* (VHF) and GPS which can automatically track ships and their traffic
- ❑ **Objective:** increase safety rates at sea

Static Data

- MMSI
- IMO
- *Call Sign*
- Ship name
- Ship Type
- Ship Dimensions

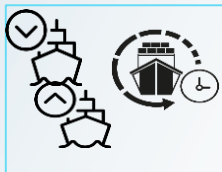
Dynamic Data

- Latitude
- Longitude
- SOG
- COG
- Navigation Status

Shipping related data

- Cruise destination
- Estimated arrival time
- *Drafts*
- Time

Research Objectives



Indonesia's Ports Calls and Vessel Duration

- count all vessels that entering and leaving Indonesian ports;
- count the time of a vessel spends in Indonesian ports.



Overseas Visits

Count Indonesia's vessels (Indonesia flag) that entering overseas ports.



Greenhouse Gas Emissions Estimates

CO₂, CH₄, and N₂O emission from shipping activities in Indonesia waters in 2022

Methodology (Data Sources)

AIS data

- <https://id.officialstatistics.org/>
- AIS exactEarth via UN Global Platform
- Year 2022
- Polygon: EEZ Indonesia
- 13 features
 - IMO
 - MMSI
 - Ship name
 - Vessel Type & Code
 - Navigation Status & Code
 - Country flag & Code
 - Latitude & Longitude
 - SOG
 - dt_pos_utc

IHS data

- <s3a://ungp-ais-data-historical-backup/register/ShipData.CSV>
- AIS exactEarth via UN Global Platform
- 5 feature
 - IMO
 - MMSI
 - Ship name
 - Gross Tonnage
 - Operator Country Of Registration

World Port Index

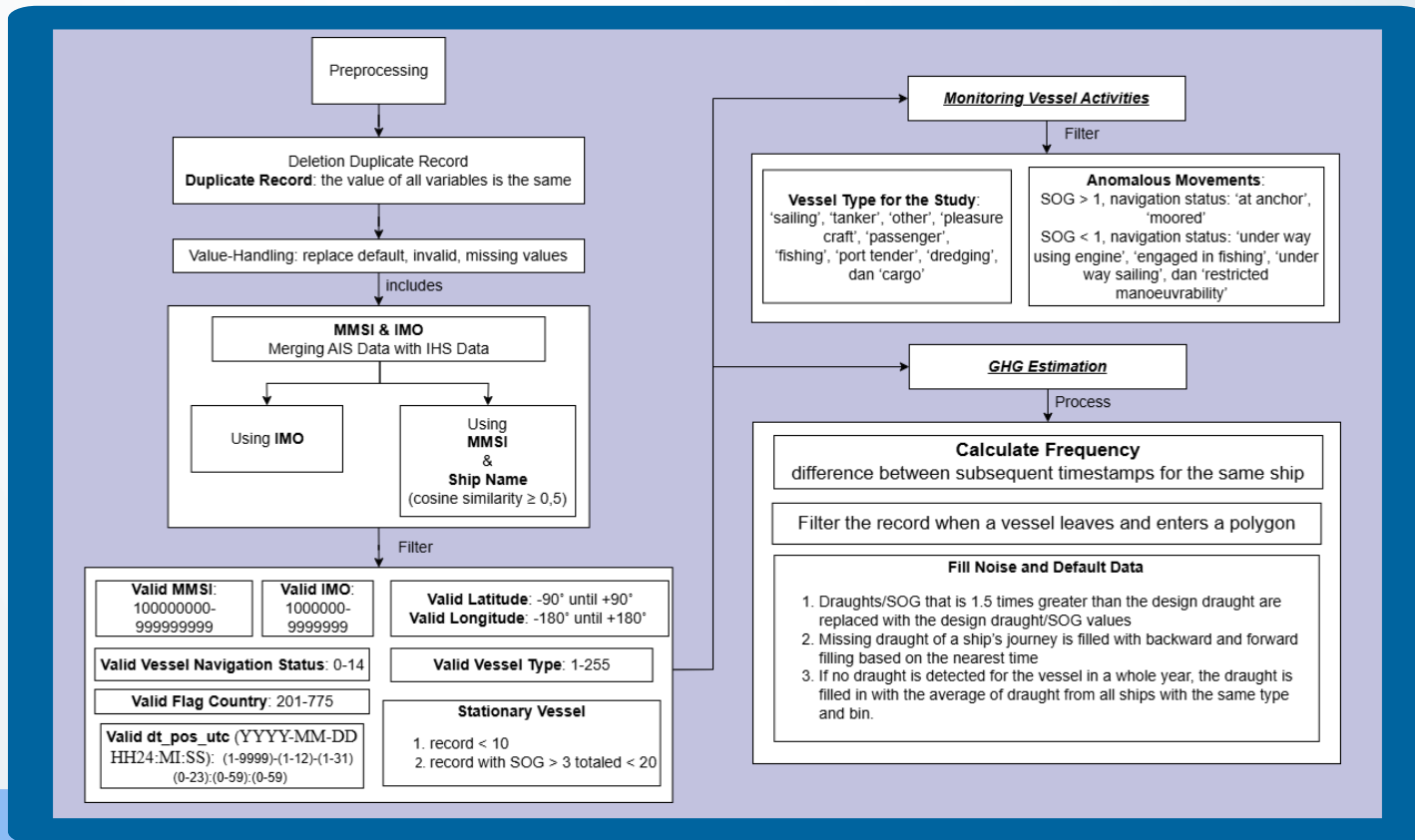
- Maritime Safety Information website
- Indonesian and World Ports

Maritime Statistics

- BPS
- Ship visit data

Methodology (Preprocessing)

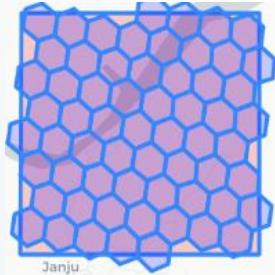
AIS data allows messages to exist *default value*, *invalid value*, *missing value*, *noise* outliers. Some things that cause this are the loss of AIS device signal, *static messages* who are susceptible to *error*, and MMSI does not comply with the provisions.



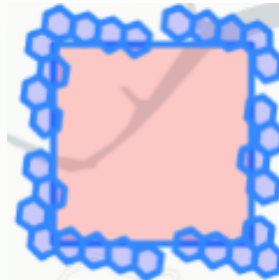
AOI & Non-AOI Indonesian Ports



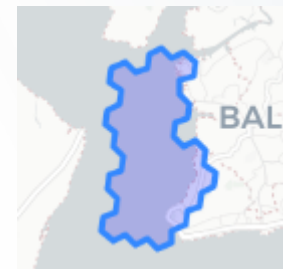
Distance Based AOI



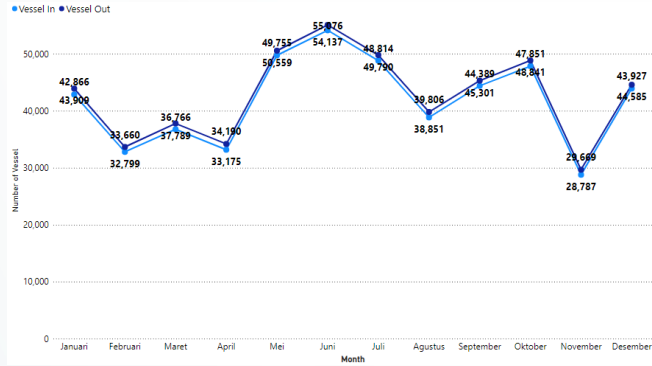
Non Area of Interest



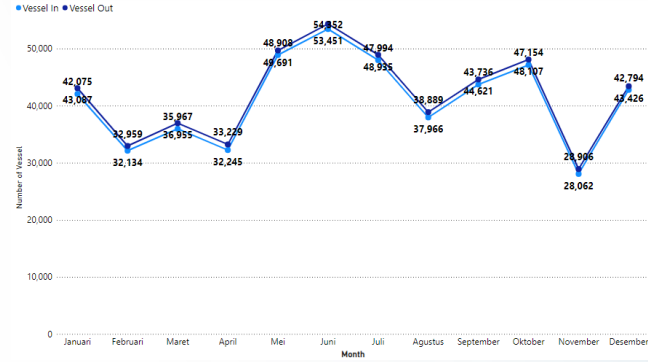
Cluster Based AOI



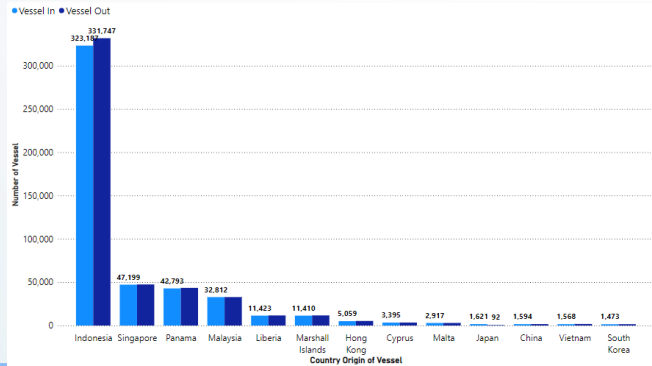
Number of Vessels in and out of Indonesian Ports per Month (Distance-Based)



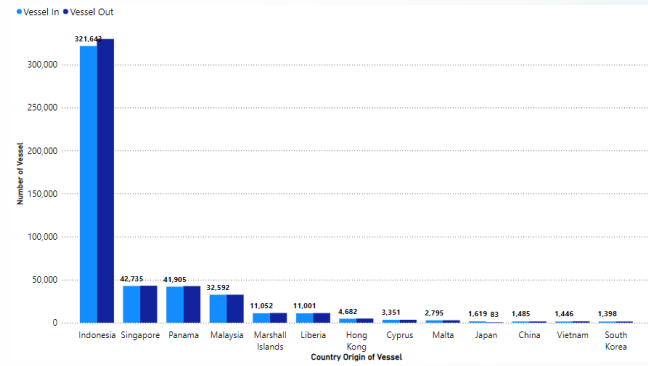
(Cluster-Based)



Number of Vessels In and Out of Indonesian Ports by Country of Origin of Ship (Distance-Based)

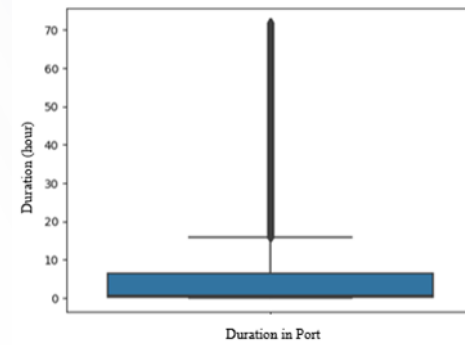
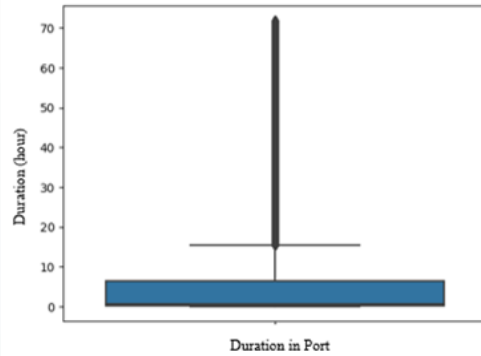


(Cluster-Based)



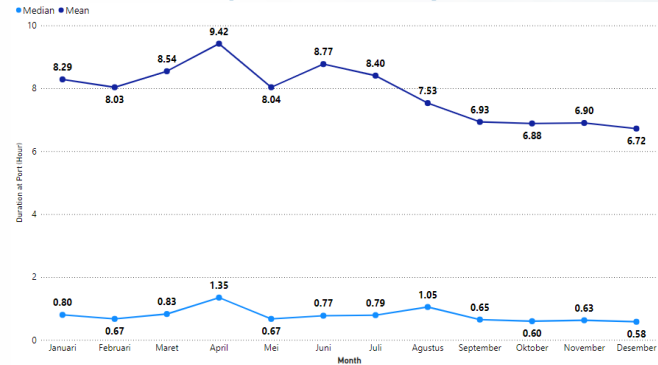
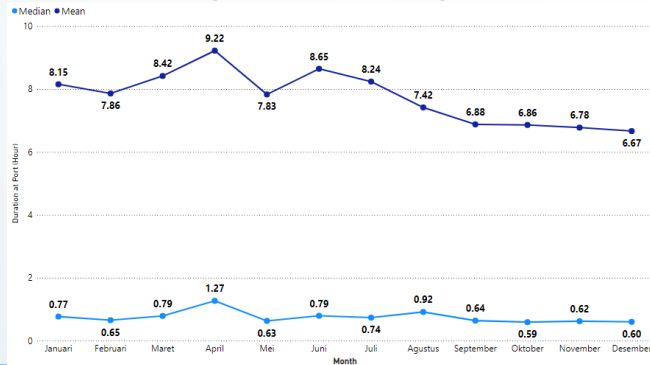
Distribution of Vessel Duration (Hours) at Indonesian Ports

(Distance-Based) (Cluster-Based)



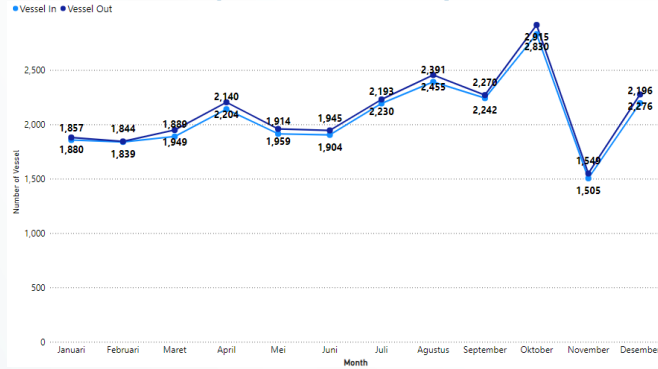
Vessel Duration (Hours) at Indonesian Ports per Month

(Distance-Based) (Cluster-Based)



Number of Indonesian Vessel Visits Overseas Port per Month

(Distance-Based)

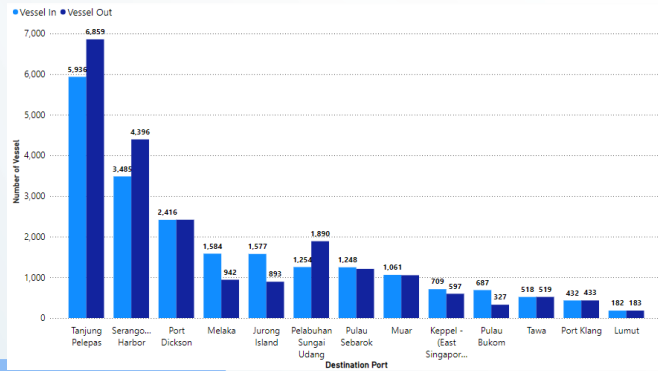


(Cluster-Based)

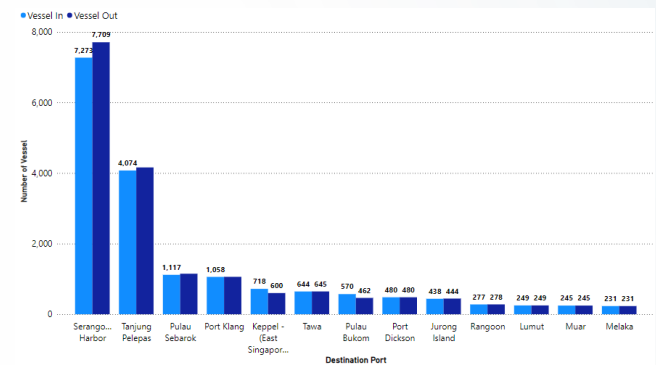


Number of Indonesian Vessel Visits Overseas Port by Destination Port

(Distance-Based)



(Cluster-Based)

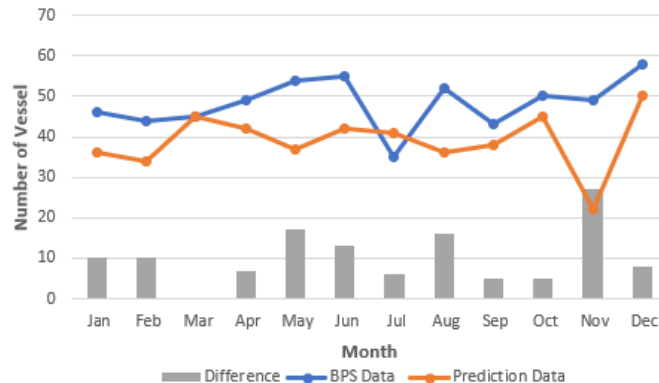


Algorithm Evaluation

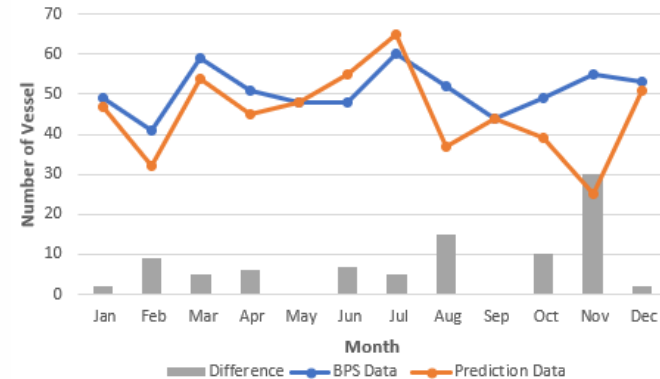
Algorithm Performance Evaluation 'Cargo' & 'Passenger' Vessel

Ports Visited	Distance-Based AOI		Cluster-Based AOI	
	RMSE	MAPE	RMSE	MAPE
(1)	(2)	(3)	(4)	(5)
Teluk Bayur	96,25443713	61,30353227	62,67043428	35,84239204
Cirebon	148,1350735	91,21597754	142,3294301	87,80385546
Banten	1603,965658	133,6675182	4895,368151	412,9450644
Benoa	611,4568668	788,3725617	603,4044387	780,3593745
Pontianak	215,3895695	83,25125159	311,8328879	131,1492983
Poso	11,13552873	68,36805556	13,40708768	85,86805556
Amamapare	83,7744989	400,9215371	127,3908029	612,0061837
70 Ports	3168090,269	16112,93984	2792095,592	14220.47038

Algorithm Performance Evaluation 'Cargo' & 'Passenger' Vessel Fakfak

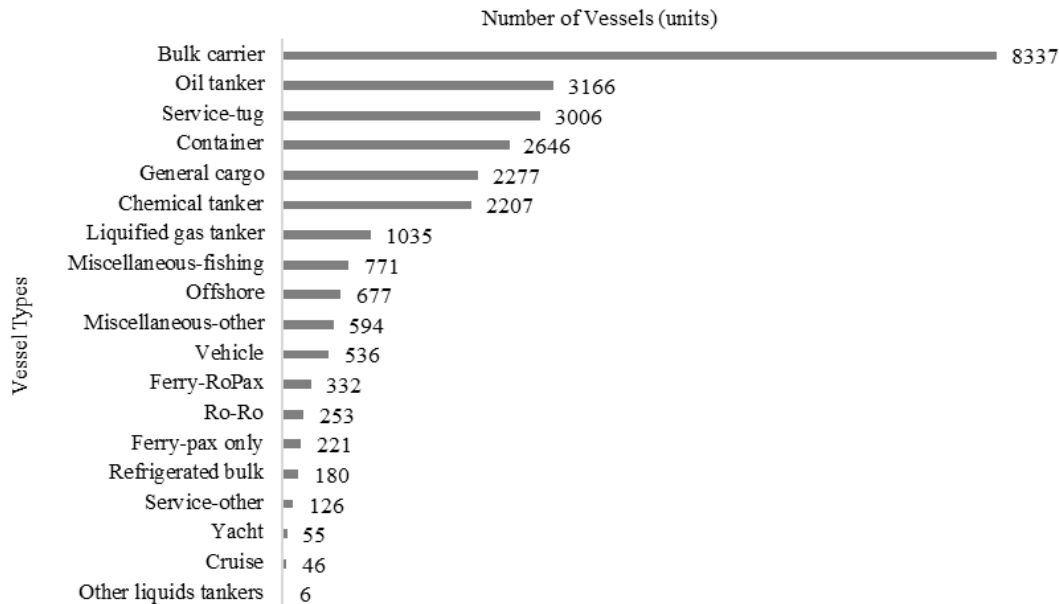


Jayapura



Results

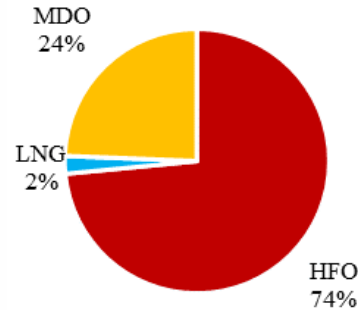
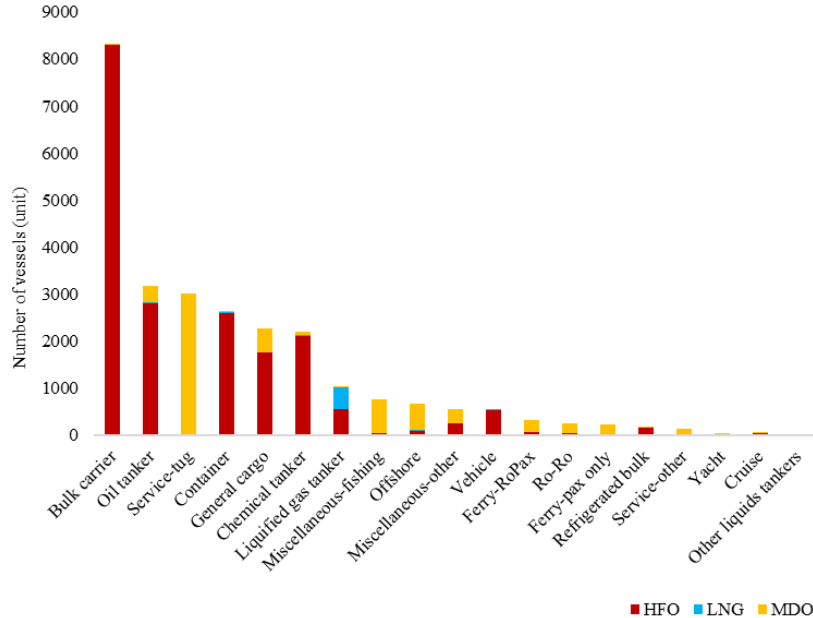
Number of vessels (units) per vessel type



The number of vessels is represented by the count of unique IMO numbers in the AIS message dataset for each vessel type.

Results

Distribution of fuel types (HFO, LNG, and MDO) from the perspective of AIS data



Fuel Types:

HFO: Heavy Fuel Oil

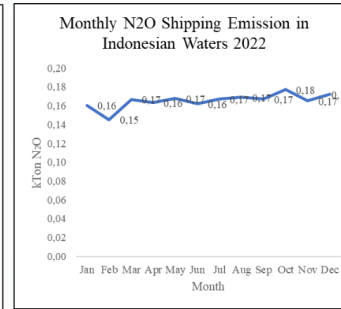
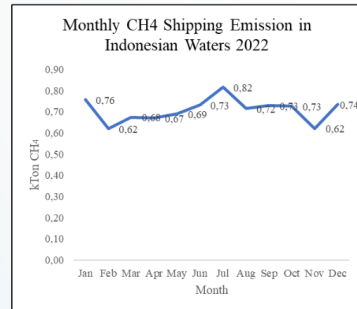
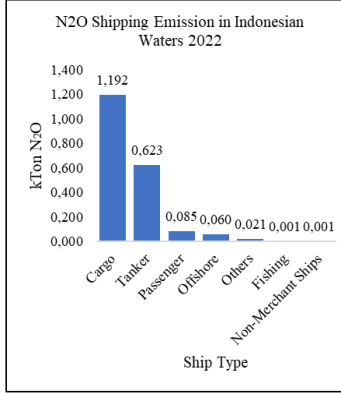
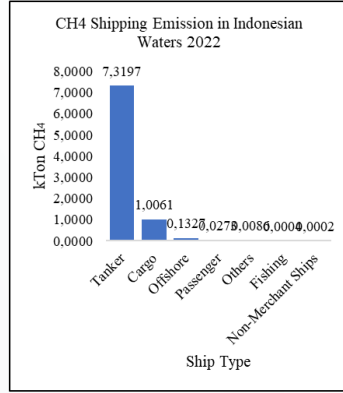
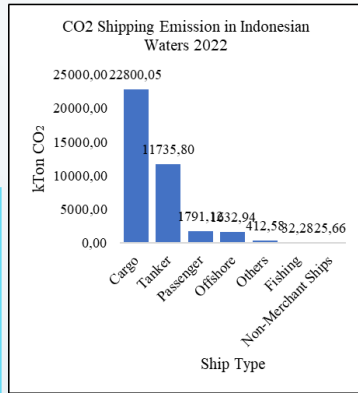
MDO: Marine Diesel Oil

LNG: Liquefied Natural Gas

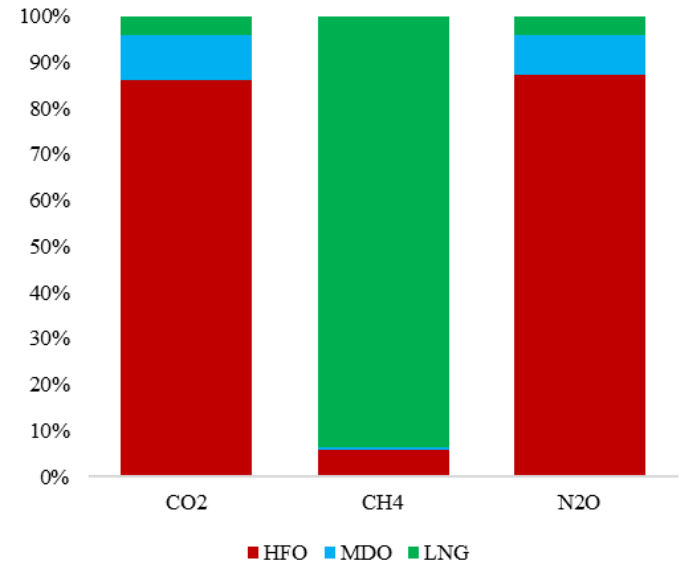
(left) Shows the distribution of fuel types used by different ship types. (right) Displays the percentage of each fuel type used by ships operating in Indonesian waters.

Results

GHG Emission Estimation from Shipping Activity



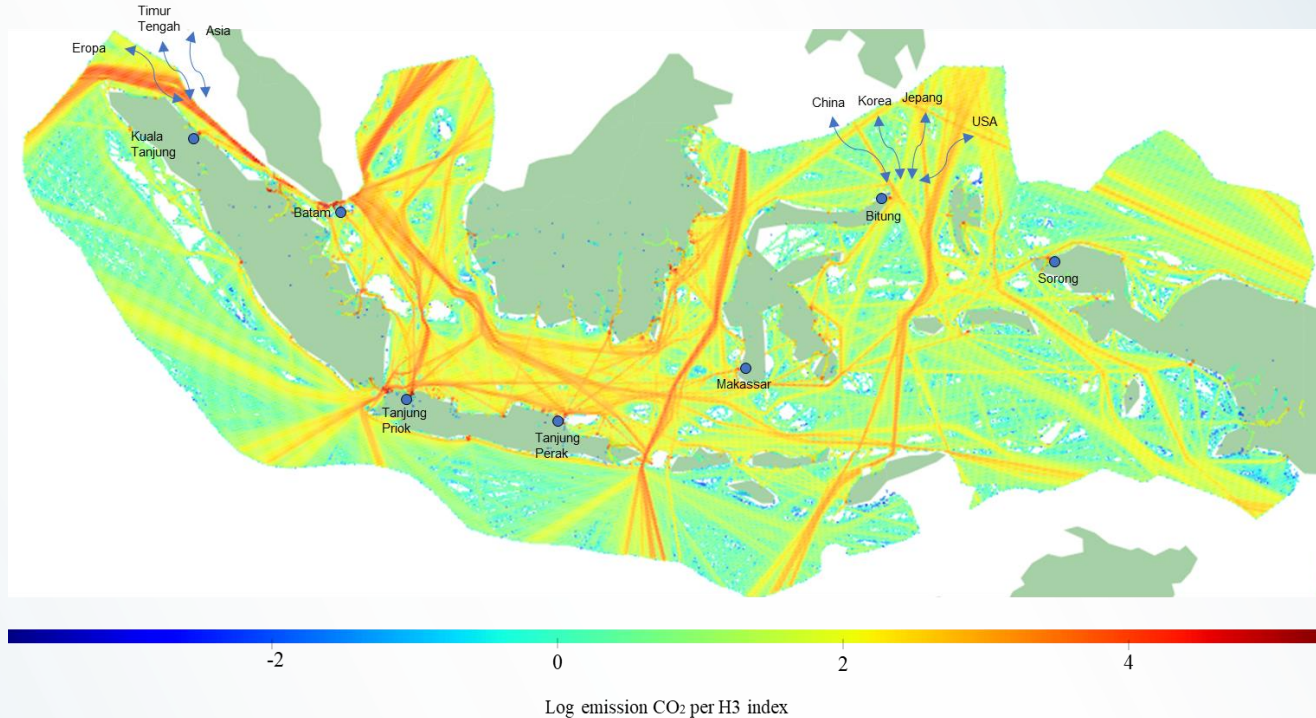
Contribution of different fuel types to greenhouse gas emissions resulting from shipping activities



■ HFO ■ MDO ■ LNG

Results

Map of GHG concentrations along shipping lanes in Indonesia (CO₂)



The map is created using H3 index resolution 6, with emission data transformed logarithmically to represent concentrations.

Limitations

(Monitoring Vessel Activities)

01

The AOIs formed by the **Distance-Based Approach** and **Cluster-Based Approach** in this study are not able to accurately define the port areas, leading to **overlapping AOIs** between neighboring ports.

*Future research could consider using other AOI methods, like **Manual AOI**, if accurate port area data is available.*

02

This study focuses on ports characterized by the **World Port Index (WPI)**, including 123 ports in Indonesia and 3,685 ports abroad.

*Consider using **port data** from the **Ministry of Transportation** to improve the accuracy of AOI modeling.*

Limitations

(Greenhouse Gas Estimation)

03

Ships that required to have AIS based on SOLAS regulation V/19:

1. All ships of \geq **300 gross tonnage**
2. Cargo ships \geq **500 gross tonnage**
3. **All** passenger ships irrespective of size.

*The use of AIS data **excludes smaller vessels** that are not required to have AIS transponders*

04

Ships that required to have IMO number based on IMO guideline:

1. Passenger ships \geq **100 gross tonnage**
2. All cargo ships \geq **300 gross tonnage**

The reliance on IHS Markit data to match vessel characteristics means that any **discrepancies in ship registration** or incomplete data could affect the accuracy

Thank You

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