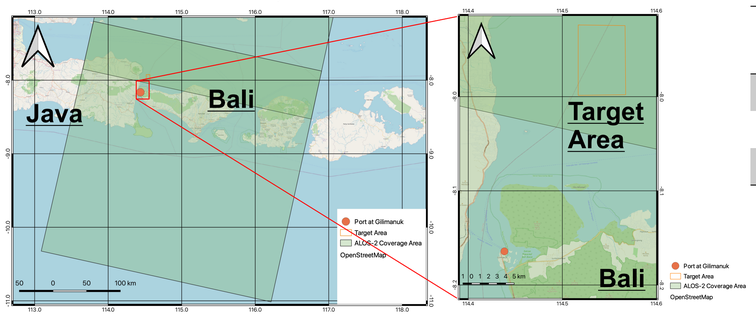
SSC23-P2-22: Combination of PALSAR-2 Observation and VDES Operation for Monitoring Illegal, Unreported and Unregulated Fishing Activities

Abstract: Indonesian Exclusive Economic Zone (EEZ) is the sixth largest in the world. Fisheries in Indonesian EEZ are active and producing high amount of products, but illegal, unreported and unregulated (IUU) fishing activities are also recognized. For monitoring and covering large area quantitatively, satellites are effective. The Indonesian government inspected 2,827 IUU fishing vessels and arrested 167 of them in 2021. It was also estimated that one illegal trawl fishing vessel would be able to lead 1.2 million USD of economic losses in Indonesia annually. The author put forward to use two different types of satellites for monitoring and managing wide areas for marine activities: radar observations and communication networks. The author and his colleagues have cooperated with Indonesian government to enhance their abilities of satellite data utilization for monitoring IUU fishing activities in Indonesian EEZ since 2021. PALSAR-2, the Japanese synthetic aperture radar (SAR) sensor on the Japanese satellite named ALOS-2 has ScanSAR Normal Mode (PALSAR-2/ScanSAR) which covers area of 350.5 km * 355 km, and it is effective for monitoring wide offshore areas of Indonesia. Although the average size of fishing vessels is less than 20 m and smaller than 50 m resolution of PALSAR-2/ScanSAR. The author and his colleagues demonstrated abilities of PALSAR-2/ScanSAR for monitoring IUU fishing activities in June 2022 by taking a vessel to West Bali on the PALSAR-2 observation date. Effectiveness of satellite utilization for monitoring IUU fishing activities was proved by the demonstration, but the monitoring frequencies and management system for fishing activities is not good enough. VHF Data Exchange System (VDES) is now expected as the next generation of Automatic Identification System (AIS) for managing vessel activities in the world. Small satellites which load VDES antenna for covering 2,000 km of radius has been discussed and examined in Japan, too. AIS is a system which transmits information to unspecified number of devices. On the other hand, VDES is expected to provide information network system in the oceans, and users would use server systems. The real time communications among vessels for accident avoidance, and business communications between the land and vessels would be realized by VDES. Moreover, constellation of about 60 small satellites which load VDES antenna would be able to cover and provide real time communication network in the whole areas of the Earth. The fishing activities would be monitored and managed by two ways: satellite data analysis for detecting vessel locations and communications among vessels. Not only monitoring IUU fishing activities but also monitoring maritime accident, realizing traceability, and managing marine resources would be realized by the combination, and it is also expected to contribute the fair marine uses.

Specification of PALSAR-2/ScanSAR:

	ScanSAR		
	WWS/WWD	WBS/WBD	VBS/VBD
Width (Swath)	350.5 km	350.5 km	489.5 km
Length (Azimuth)	355 km	355 km	355 km
Time Duration of Azimuth Direction	52 seconds	52 seconds	52 seconds
Pixel Spacing Level 2.1	25 m/50 m/100 m		
Polarization	Single (HH, HV, VH, or VV) Dual (HH+HV or VH+VV)		

Observation Area: Author hired and took a fishing vessel to the West Bali for being observed by PALSAR-2/ScanSAR on June 12, 2023.



Observation Time of PALSAR-2/ScanSAR (UTC)	
Start	2022-06-12 03:57:28
Center	2022-06-12 03:57:52
End	2022-06-12 03:58:17

Target Vessel: The illegal vessel sizes were 50 – 70 gross tons according to ex-Minister Susi's comment in 2014, and their vessel lengths were estimated as 20 m by European gross tonnage calculator as given in Council Regulation (EC) No 3259/94.

Specification	Detail
Name	KMN. INKA MINA 332
Country	Indonesia
Type	Fishing Vessel
Material	33 gross tons
Weight	17.6 m
Height	1.58 m
Width	4.36 m
In Service	2012

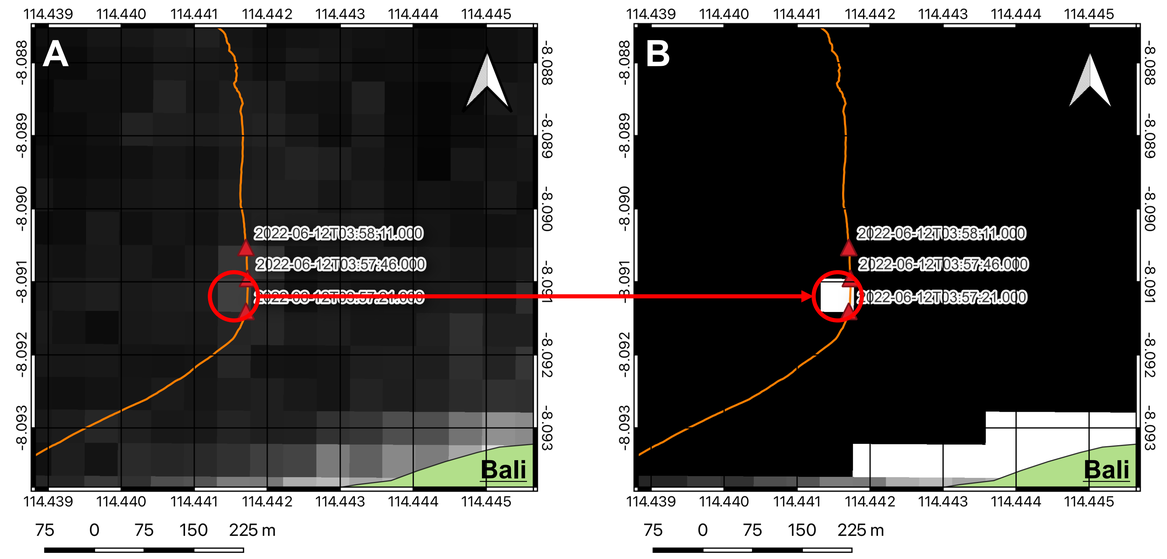
Calculation for Vessel Detection:

$$I_T = c\,(< I > + \sigma_I)$$

Where
I_T: the threshold value
</>: the mean image intensity or amplitude
σ_I: standard deviation
c: constant (empirically selected)

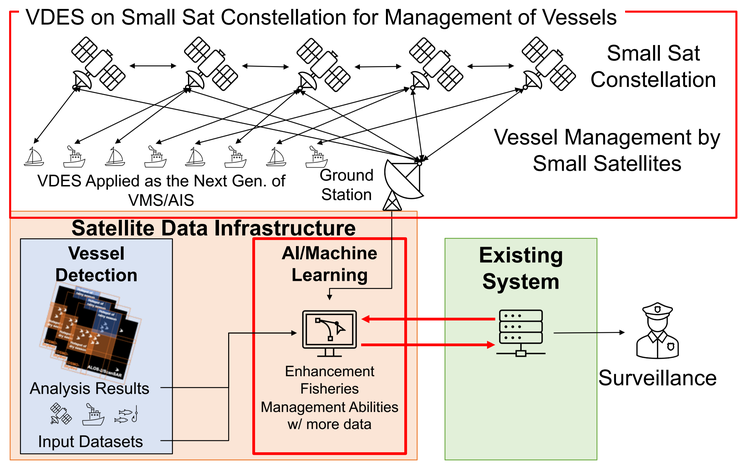
- The threshold value was set by using the mean value and standard deviation of the data.
- HH-polarization was used.

Result:



- The vessel was recognized on the power image (Figure A).
- The vessel was extracted by data analysis (Figure B).
- ALOS-2/ScanSAR may have abilities to observe vessels less than 20m.
- The geographic coordinate systems of both images are WGS 84.

Future Action:



- PALSAR-2/ScanSAR has 50 m resolution, but its abilities was demonstrated to detect smaller size (17.6-meter length) of fishing vessel.
- VHF Data Exchange System (VDES) is now expected as the next generation of Automatic Identification System (AIS) for managing vessel activities in the world.
- As the next step, author and his colleagues will develop and operate VDES satellite.
- Combination of satellite data analysis and real time monitoring system by VDES satellite constellation will enhance not only monitoring IUU fishing activities but also monitoring maritime accident, realizing traceability, and managing marine resources would be realized by the combination, and it is also expected to contribute the fair marine uses.

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