

TALOS: An End-to-End AI Framework for Operational SAR Oil Spill Monitoring

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Motivation

Marine oil spills are a **major environmental threat**, requiring **timely and reliable monitoring**.

Synthetic Aperture Radar (**SAR**) is a key technology for oil spill monitoring, providing:

- **All-weather observations**
- **Day-and-night imaging**
- **Wide-area maritime coverage**

However, turning **SAR imagery into actionable information** still involves **multiple processing steps, different tools, and expert interpretation**.

TALOS is a **modular end-to-end AI framework** that turns **Sentinel-1 SAR imagery into operational oil spill information**, from **detection to scene-level analysis**.

Results

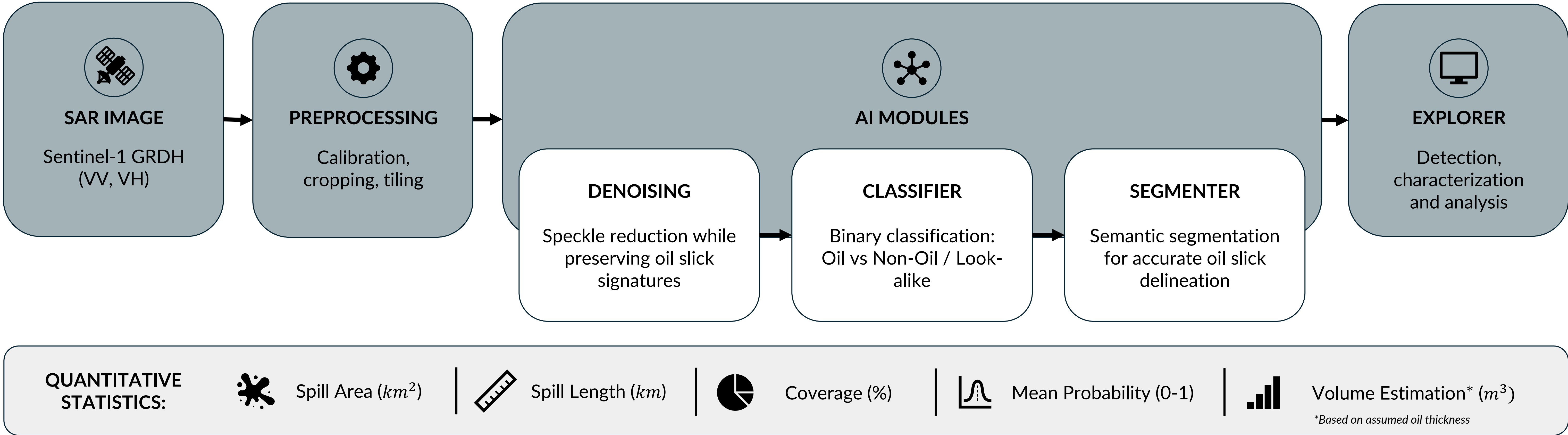
- **Classification:** Robust across SAR representations, with **VV + VH** as the preferred input configuration.
- **Segmentation:** **AI-denoised VV** provides the most effective input for oil slick delineation.
- **AI denoising:** **+4.6 dB PSNR** (**–41% RMSE** reduction), while preserving oil slick structures.

	Accuracy	Precision	Recall	F1-score	IoU
Classification (AI denoised, VV + VH)	89.11%	91.06%	74.67%	82.05%	
Segmentation (AI denoised, VV)	99.18%	83.09%	88.61%	85.76%	75.07%

PSNR: Peak Signal-to-Noise Ratio; RMSE: Root Mean Square Error; IoU: Intersection over Union

TALOS Framework

Pixel-wise predictions are automatically transformed into meaningful **scene-level operational information**.



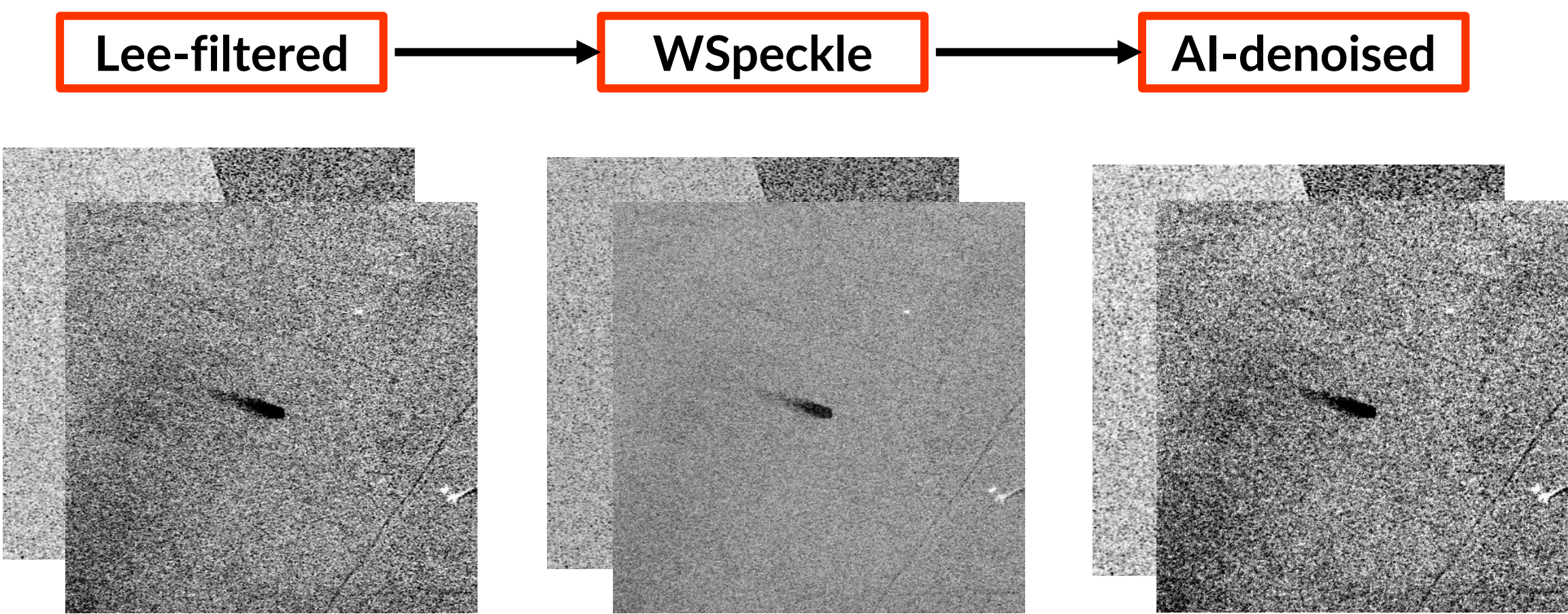
Experimental Design & Representation Study

A public Lee-filtered Sentinel-1 GRDH SAR dataset* containing 512×512 dual-polarization (VV/VH) oil, non-oil, and look-alike patches.

	Train	Validation	Test
Oil	792	408	150
No-Oil	396	204	150
Lookalike	396	204	150

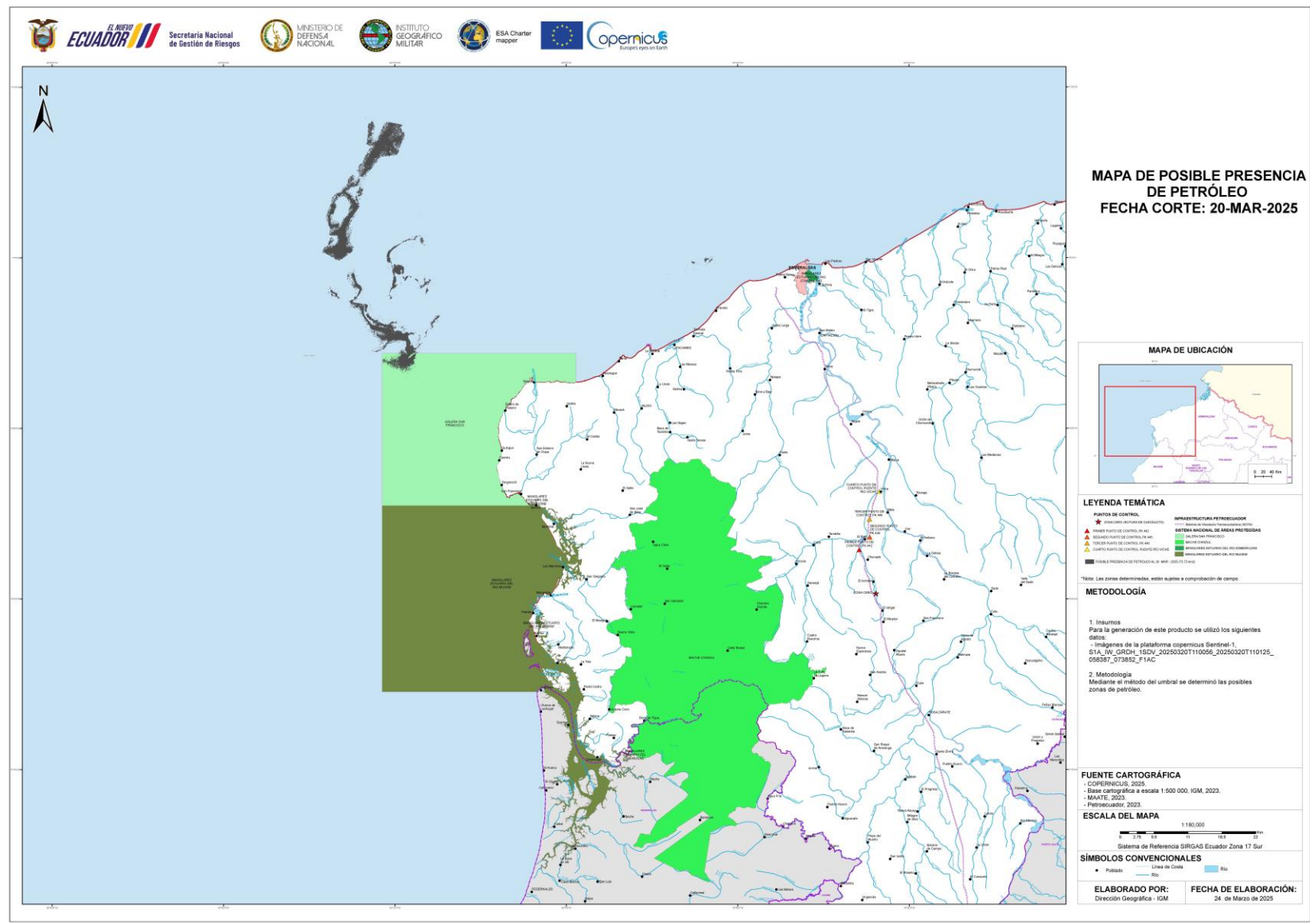
*Sentinel-1 SAR Oil spill image dataset for train, validate, and test deep learning models.

Two additional representations were derived from the Lee-filtered dataset: **WSpeckle** (simulated speckle) and **AI-denoised** (our AI-based denoising model).



Real Case Study

International Charter Activation #954 – Ecuador Oil Spill (2025). Following the SOTE pipeline rupture, a Charter product derived from Sentinel-1 identified **73.72 km² of possible oil presence**. **TALOS** was tested on the same Sentinel-1 GRDH acquisition.



Input

Probability Map

Prediction Map

Mask Overlay

Interactive Dashboard

