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10.05.2026

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Stimare la pesca industriale globale

Con dati satellitari e di tracciamento delle navi

Estimating Global Industrial Fishing

With satellite and vessel-tracking data

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1. Introduzione

- **Il problema:** Non tutti i paesi condividono i propri dati sulla pesca nelle loro acque.
- **La sfida:** Nessuna fonte di dati è perfetta da sola (le navi possono spegnere i tracker; i satelliti perdono le piccole imbarcazioni).
- **La nostra soluzione:** Combiniamo due fonti – tracciamento navale (AIS) + radar satellitare (SAR).
- **Il risultato desiderato:** Un quadro più completo dell'attività di pesca globale.

1. Introduction

- **The problem:** Not all countries share their fishing data.
- **The challenge:** No single data source tells the full story (ships camm turn off their tracker; satellites miss small boats).
- **Our solution:** Combine two sources – ship tracking (AIS) + satellite radar (SAR).
- **The desired result:** A clearer, more complete picture of global fishing activity.

2. Metodologia

Dati SAR (ESA Sentinel-1)

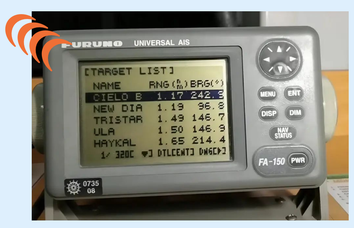
- Attivo: invia impulsi a microonde, riceve l'eco
- Penetra le nuvole

Dati AIS

- Segnale radio presente sulle navi
- Per evitare collisioni
- Può essere spento

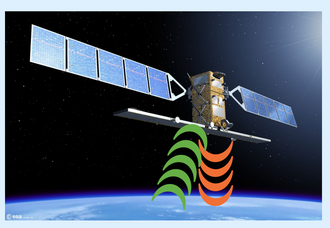
AIS

Automatic Identification System



SAR

Synthetic Aperture Radar



Un modello statistico dedicato che combina entrambe le fonti, tenendo conto dei bias di ciascuna

Modello Bayesiano / Bayesian model

AIS + SAR → Pesca reale / Real fishing

$$\underbrace{p(z,\beta,\theta \mid AIS, SAR)}_{\text{posterior fishing intensity and model parameters given AIS and SAR evidence}} \propto \underbrace{p(AIS \mid z)}_{\text{AIS likelihood, given fishing activity } z} \underbrace{p(SAR \mid z)}_{\text{SAR detection likelihood, given fishing activity } z} \underbrace{p(z \mid \beta,\theta)}_{\text{latent fishing intensity model (covariates + spatial/temporal structure, e.g. SST)}} \underbrace{p(\beta)}_{\text{prior for fixed-effect coefficients}} \underbrace{p(\theta)}_{\text{hyperprior for covariance etc.}}$$

2. Methods

SAR Data (ESA Sentinel-1)

- Active: sends μ-wave pulse, receives echo
- Penetrates clouds

AIS Data

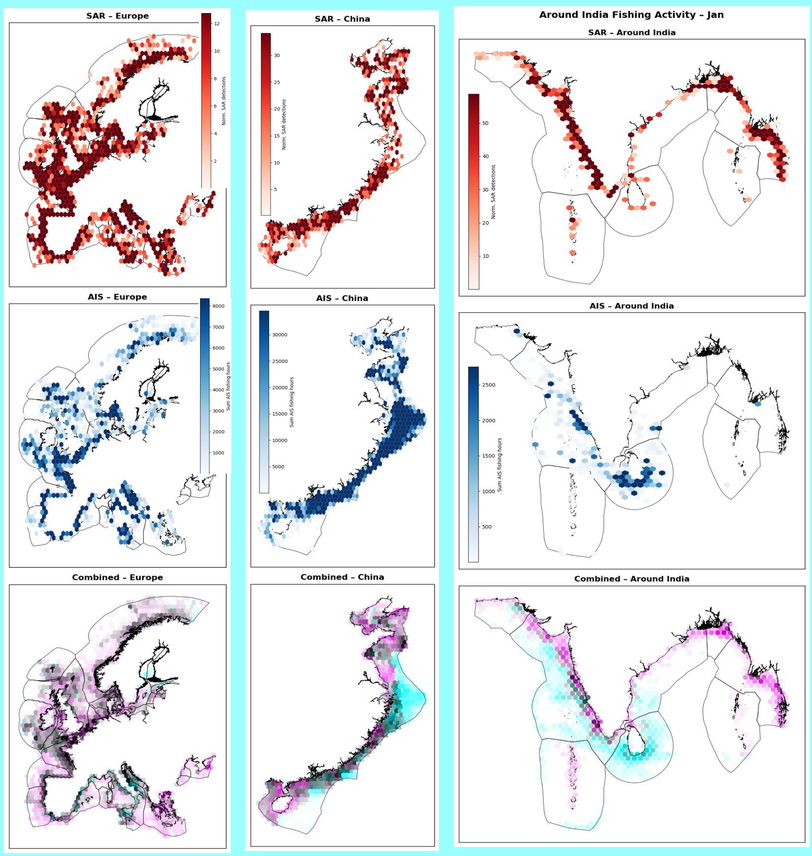
- Radio signal on ship
- To avoid collisions
- can be turned off

A special statistical model that combines both sources accounting for each source's biases

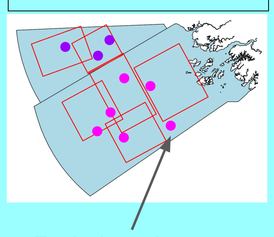
$u(s,t)$: ground-truth fishing intensity
$z(s,t) = \log(u(s,t))$
SAR, AIS : satellite and AIS tracking observations
β : weights of the fixed effects on fishing (e.g. SST, depth)
θ : Gaussian field hyperparameters (e.g. covariance)

3. Risultati

- AIS e SAR si completano a vicenda
- Né AIS né SAR da soli rappresentano la verità
- Elaborazione dei dati SAR: sommare le probabilità SAR fornisce la migliore stima dei dati di pesca da SAR.



SAR detectios



Each detection one score / un punteggio per ogni rilevazione

$$\frac{\sum detections_i}{\sum area\ imaged_i}$$

3. Results

- AIS and SAR are complementary
- Neither AIS nor SAR alone is ground truth
- SAR processing: Summing SAR probabilities gives the best estimate of SAR fishing data

4. Discussione e Conclusioni

Nessuna singola fonte dà un quadro completo della pesca globale. Combinando i dati AIS e SAR con un modello statistico (bayesiano) otteniamo una stima più affidabile, e possiamo capire dove e quanto si pesca davvero nel mondo.
Prossimo passo: collegare l'attività di pesca con la biodiversità marina e il benessere delle comunità costiere.

4. Discussion and Conclusions

No single source gives a full picture of global fishing. By combining AIS and SAR with a statistical (Bayesian) model, we get a more reliable estimate, revealing where and how much fishing really happens.
Next step: link fishing activity to marine biodiversity and the wellbeing of coastal communities.

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