HUMAN IMPACTS OF THE MOTORWAYS OF THE SEA

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EGU 2014, Vienna, Austria

IMEDEA

CSIC

Universitat de les Illes Balears

SOCIB Balearic Islands Coastal Observing and Forecasting System

INTEGRATED ASSESSMENT OF SHIP-BASED ACTIVITIES

Societal needs

Technological development

Science-based tools

SHIP-BASED ACTIVITIES: BLUE GROWTH

▲ Oil & gas

▲ Shipping

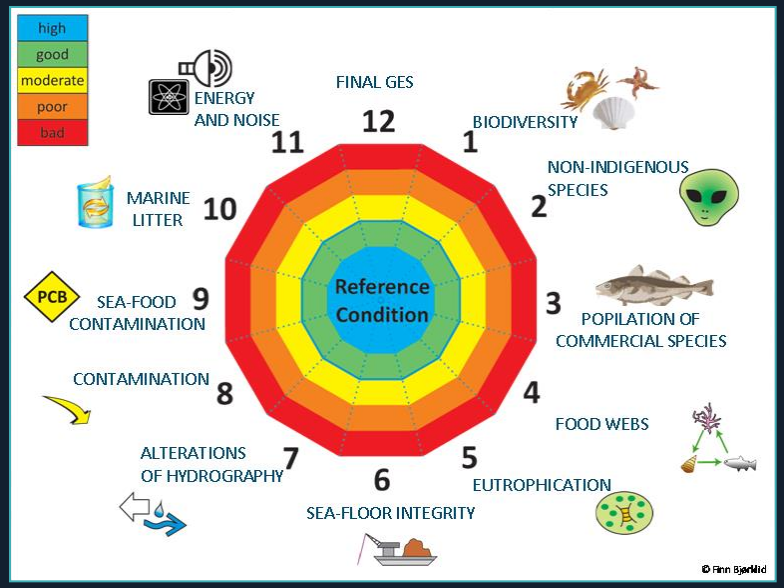
▲ Passenger ferry

▲ Cruise tourism

▲ Fisheries

▲ Recreational boating

PRESSURES ON MARINE ECOSYSTEMS



- Ship-based activities have the potential to affect any of the eleven qualitative descriptors targeted by the Marine Strategy Framework Directive (MSFD)

▲ Yatch anchor over seagrass

E.g. Descriptors 1, 6

▲ Oil spill

E.g. Descriptors 8, 9

▲ Overfishing

E.g. Descriptors 3, 4

COMPETITION FOR MARITIME SPACE

- Fishermen complain against cruise ships mooring over fishing grounds

- Civil society complains against coastal development

- Deployment of oceanographic buoys taking into account shipping lines and fishing grounds to avoid interactions

SOCIETAL CHALLENGES

Sustainable developmet
Integrated Maritime Policy

Stakeholders involvement
MSP Directive (proposal)

http://www.msfd.eu/

Ecosystem based management
MSFD Directive

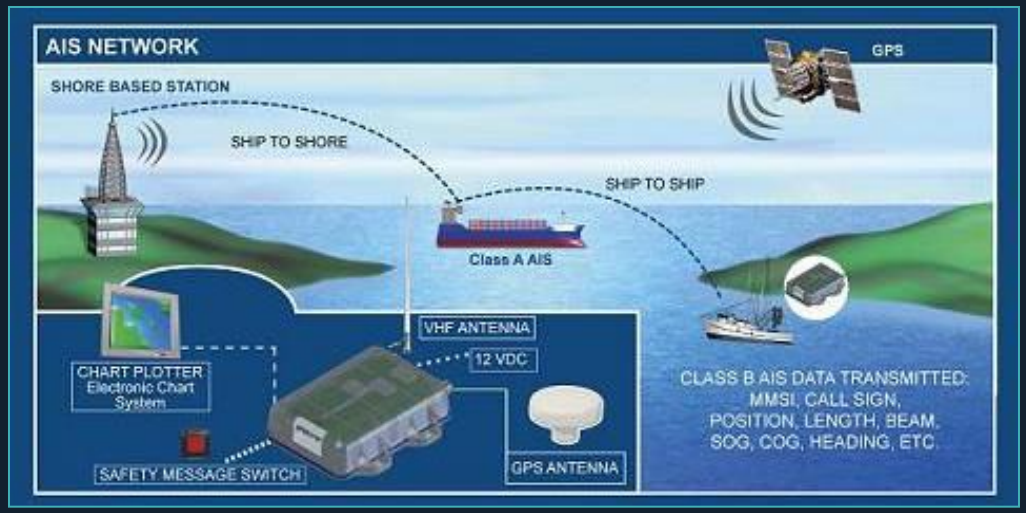
2012 MSFD TIMELINE 2020

INITIAL ASSESSMENT | ENVIRONMENTAL TARGETS | MONITORING PROGRAM | PROGRAM OF MEASURES | GOOD ENVIRONMENTAL STATUS

WATCH MARINE TRAFFIC FROM A NEW PERSPECTIVE

MONITORING MARINE TRAFFIC

Spatio-temporal patterns of ship-based activities



http://www.marineelectronicsjournal.com/

WHO IS REQUIRED TO CARRY AIS?

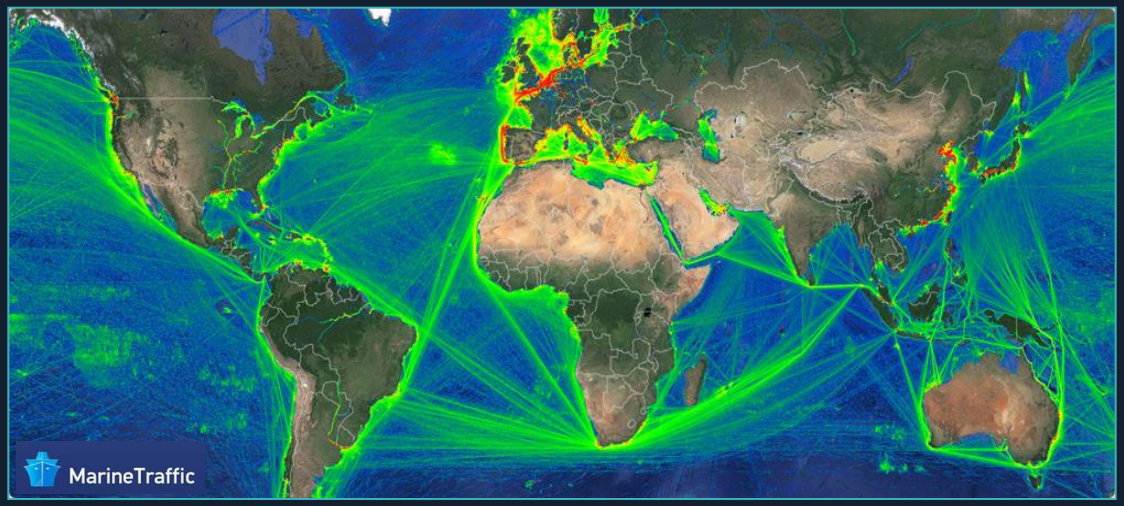
- All ocean-going commercial traffic >300 gross tons
- Ferries carrying more than 165 passengers
- Tug & Tows
- EU fishing fleet > 15 m

DATA ACQUISITION

- Install your own antenna
- National port authorities
- Regional conventions (eg. HELCOM)
- Global providers (eg. MarineTraffic)

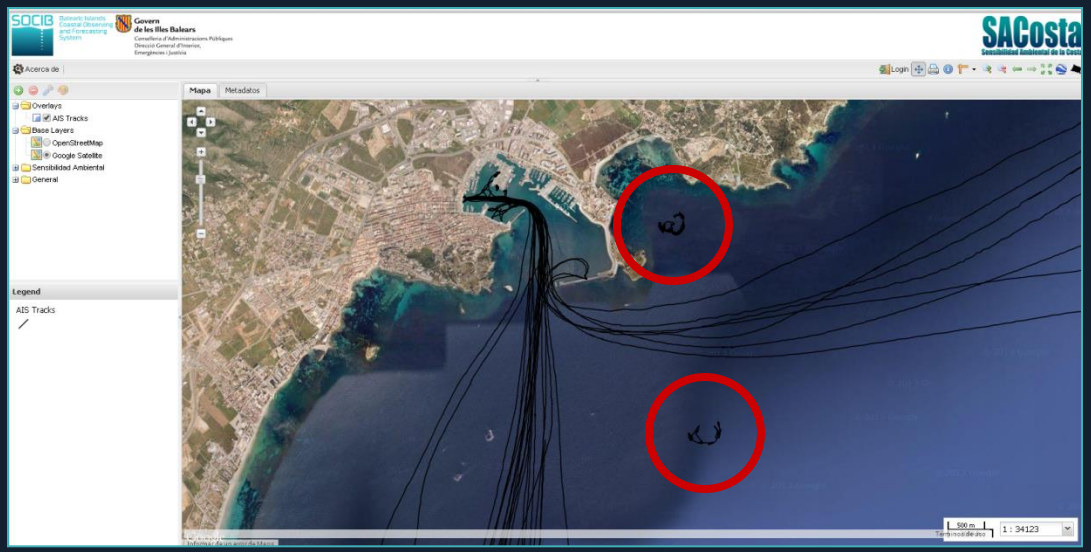
- SOCIB's AIS antenna and spatial coverage

THE SCALE ALSO MATTERS



- Shipping intensity
  - Global scale
  - Regular lines

- Recreational boat anchoring
  - Ibiza island (NW Mediterranean)
  - Anchoring for few hours/days

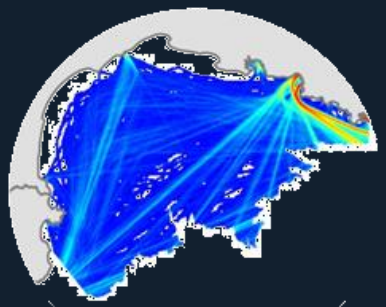


DATA MANAGEMENT

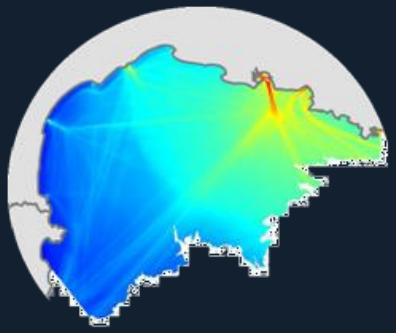
- Open source geospatial technologies

- Data storage: spatial databases
- Data cleaning: duplicates, invalid codes, …
- Geospatial filters: point or track on land, …
- Geospatial processing: Point to Track
- Calculate metrics: speed, turn angle, …

DATA-INTENSTIVE SCIENTIFIC DISCOVERY



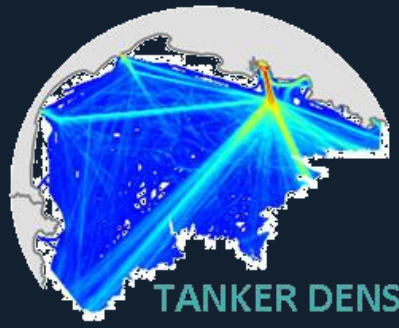
TRAFFIC DENSITY



UNDERWATER NOISE

AIS DATA

RISK OF INTRODUCTION OF ALIEN SPECIES



TANKER DENSITY

RISK OF INTRODUCTION OF SHIP-TRANSPORTED ALIEN SPECIES

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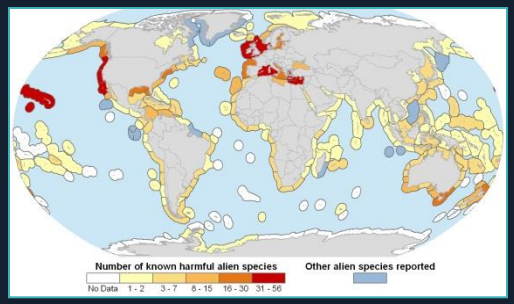
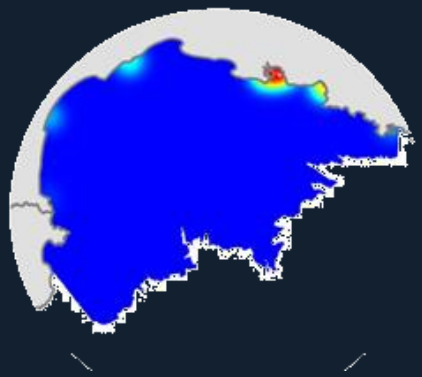


- Global shipping network
  Keller et al. 2011
- Port environmental distance
  Keller et al. 2011
- Distribution of alien species
  Molnar et al. 2008

SPATIAL MODELLING

- Relative probability index (Chan et al. 2013)
- Exponential decay function (Ban et al. 2010)



UNDERWATER NOISE

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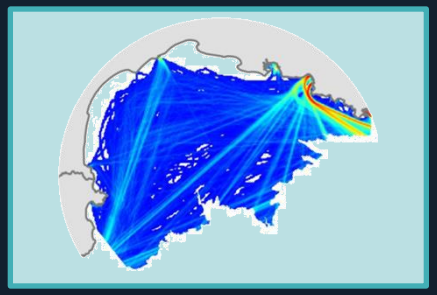

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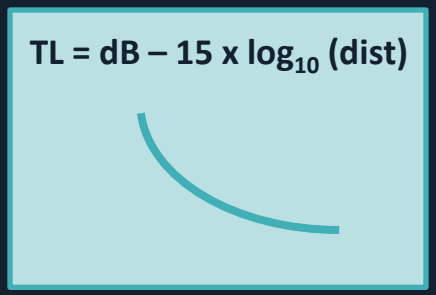


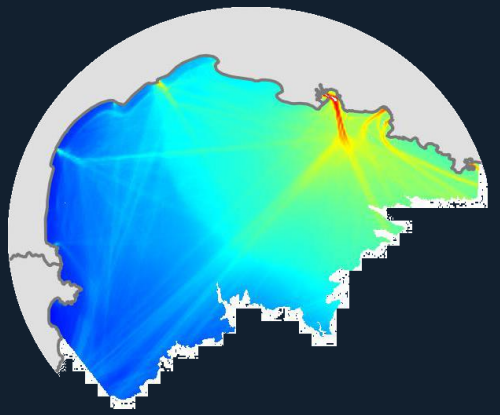
Source levels per boat type
Hatch et al. 2008

Navigation time per grid cell

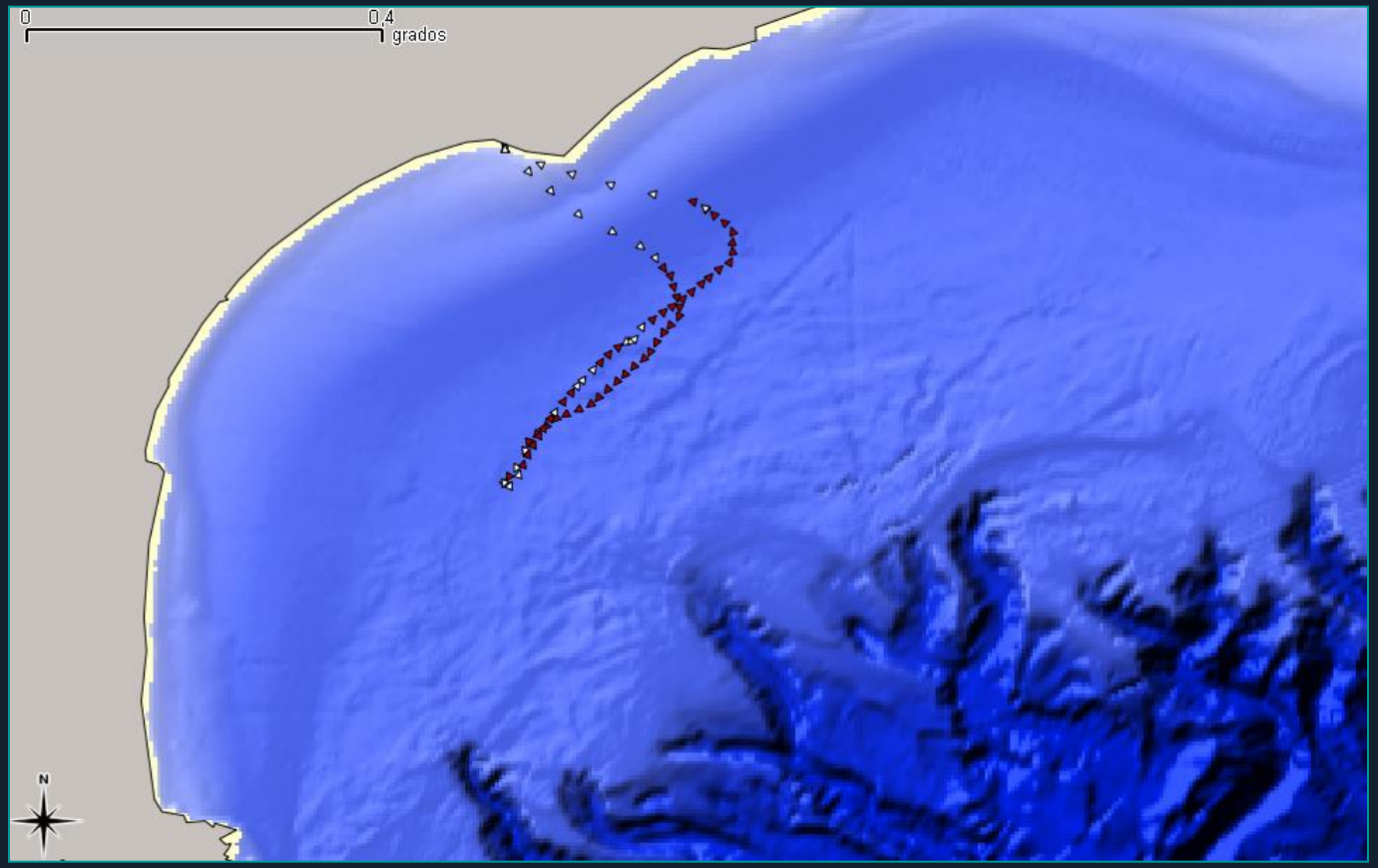
Transmission loss function
Erbe et al. 2012

SPATIAL MODELLING

- Propagates cell by cell using a moving window approach (March et al. in prep)



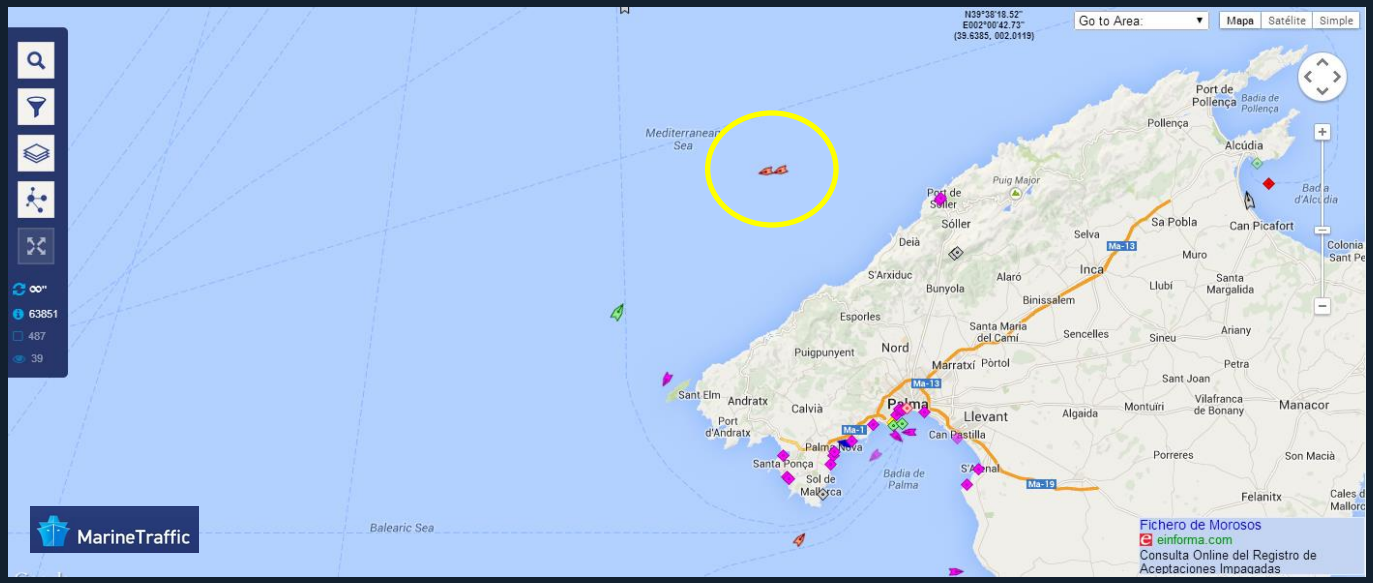
FISHING BEHAVIOUR



- Fishing activity

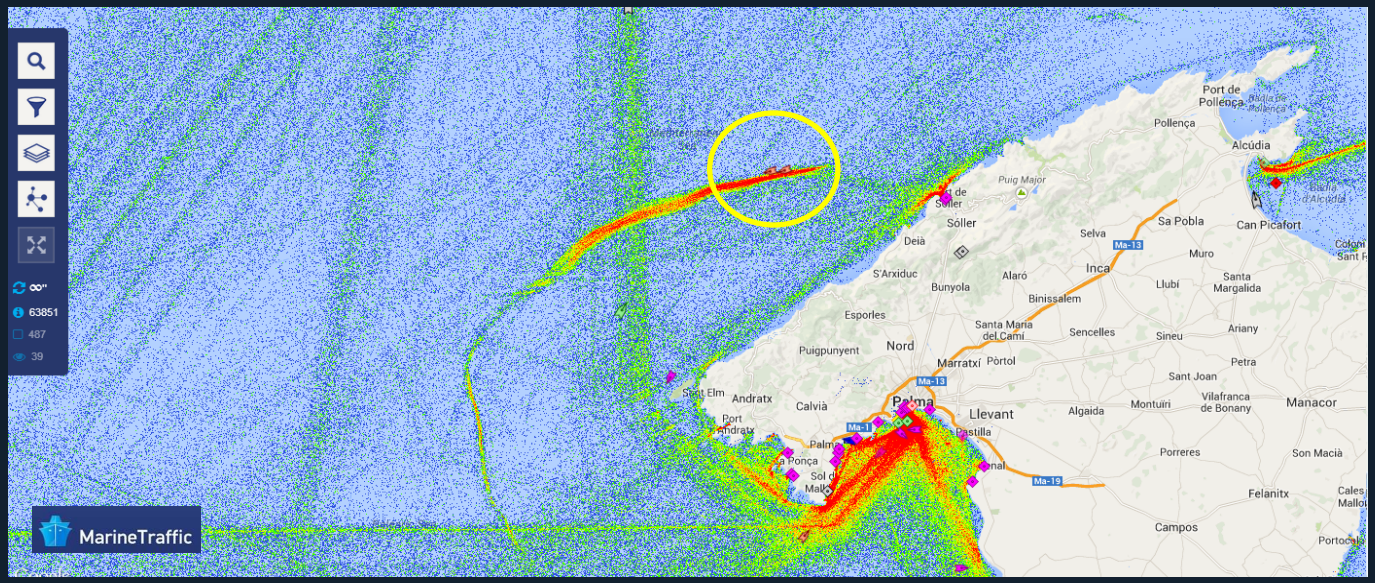
  Define fishing and navigating states based on speed profile (‘vmstools’ package in R)

FISHING BEHAVIOUR



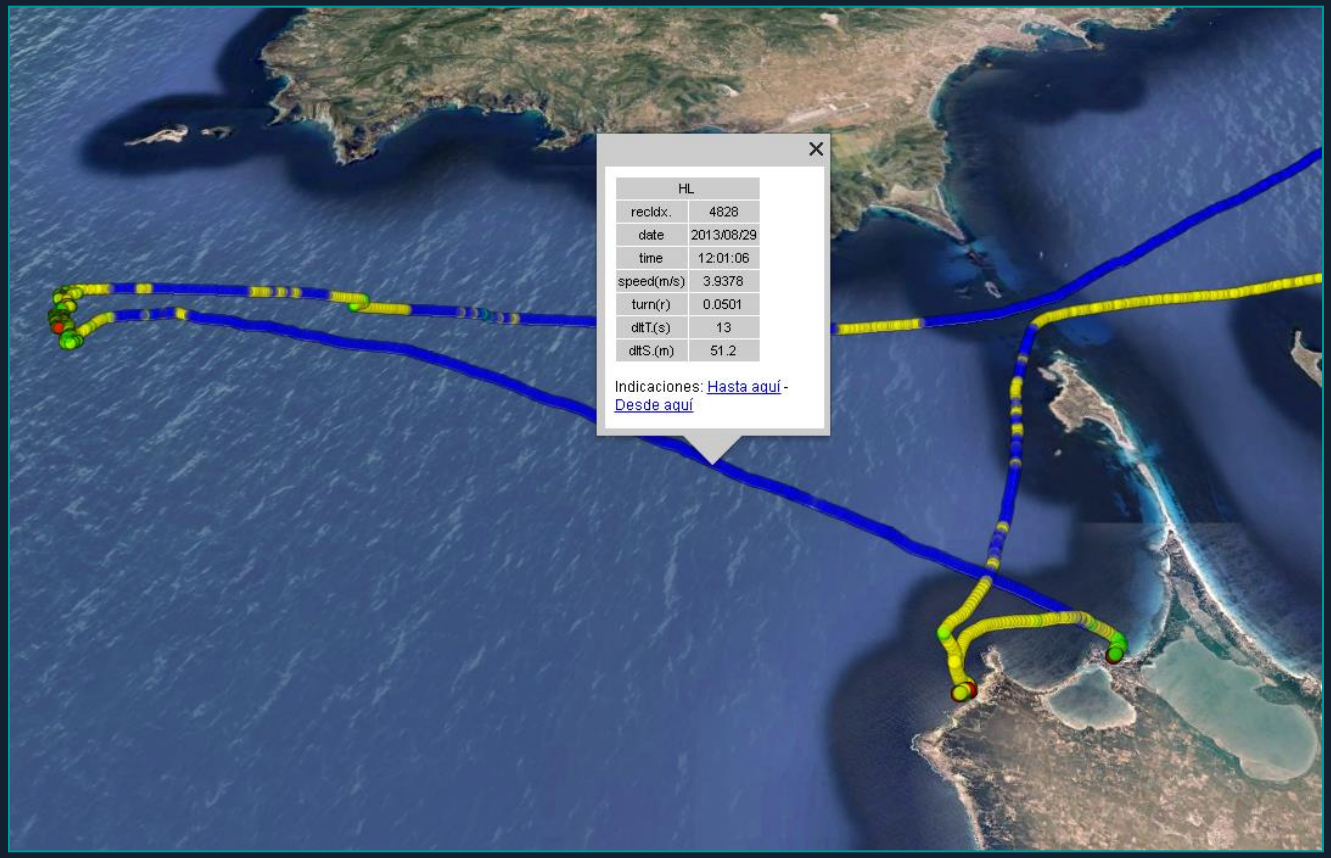
- Two trawlers were sighted in north Mallorca

FISHING BEHAVIOUR



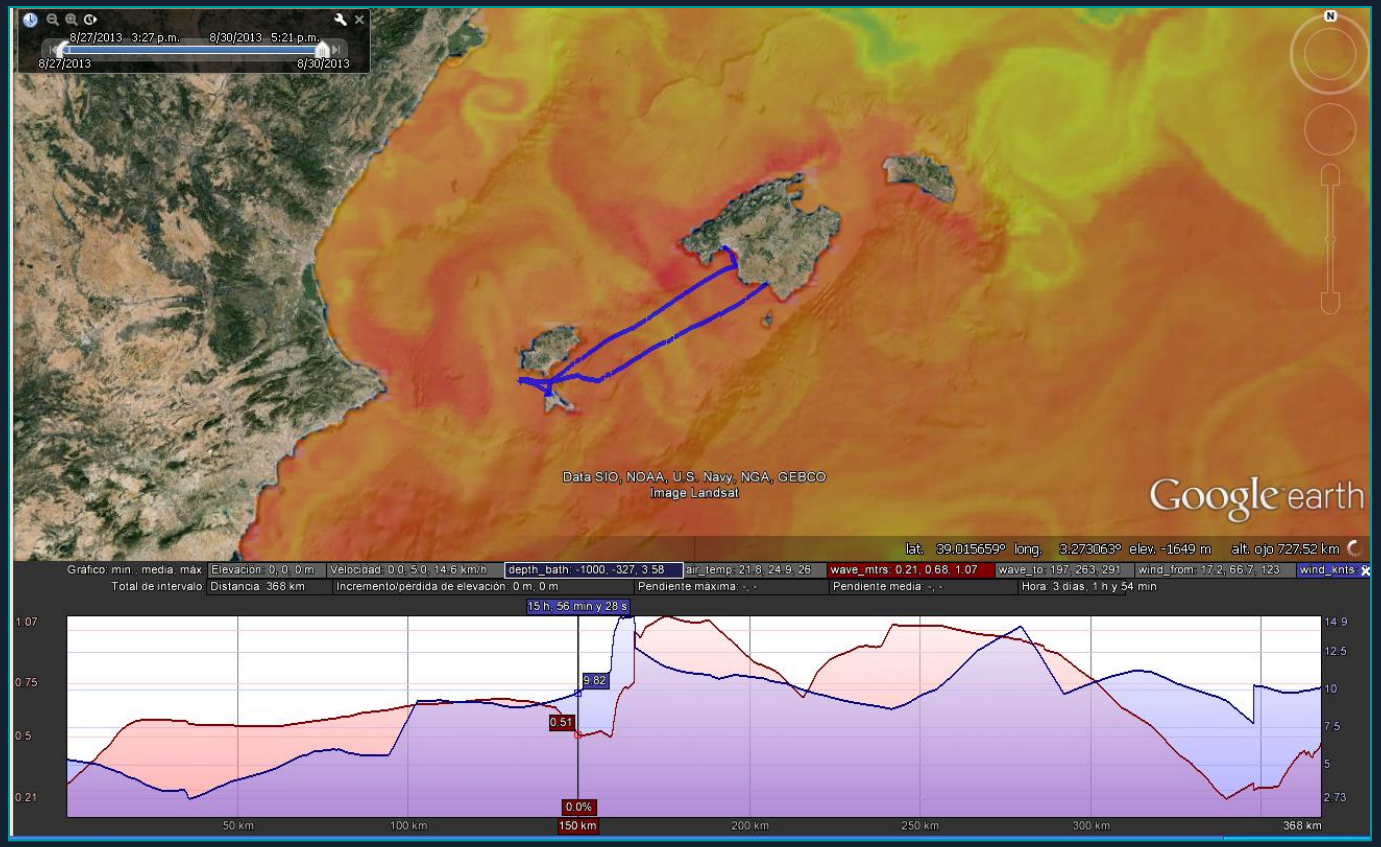
- Density maps based on historical information illustrates the prevalence of fishing grounds

RECREATIONAL BOATING BEHAVIOUR



- Sailing track with different states identified (e.g., sailing, motor, moored, operations)
  Unsupervised algorithm using Expectation-Maximization Binary Clustering ('EMbC ' package in R, Movelab)

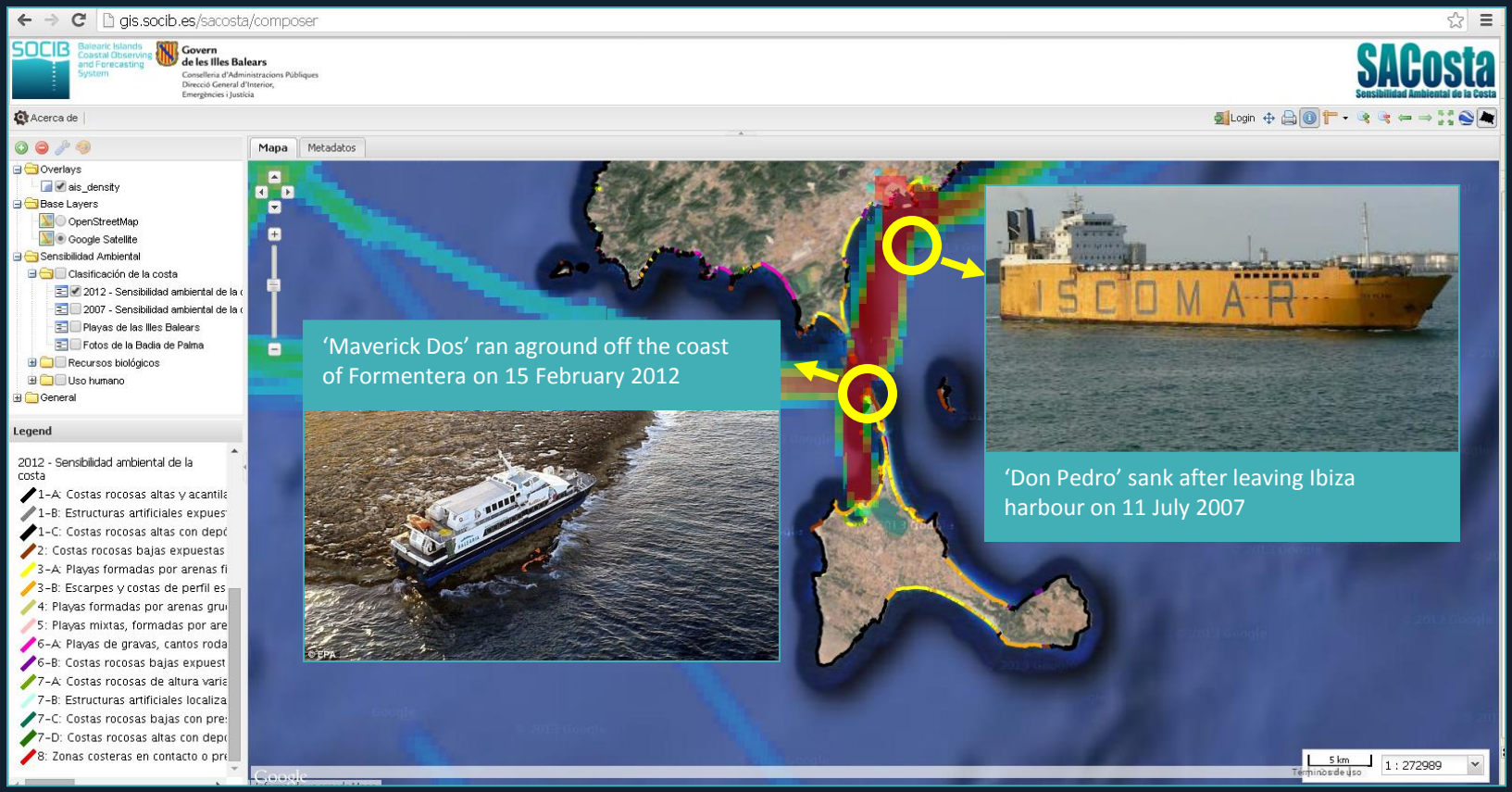
APPLICATIONS: OCEANOGRAPHIC INFO ALONG TRACK



- Temporal profile with wave height (red) and wind speed (blue) along a 5-day track

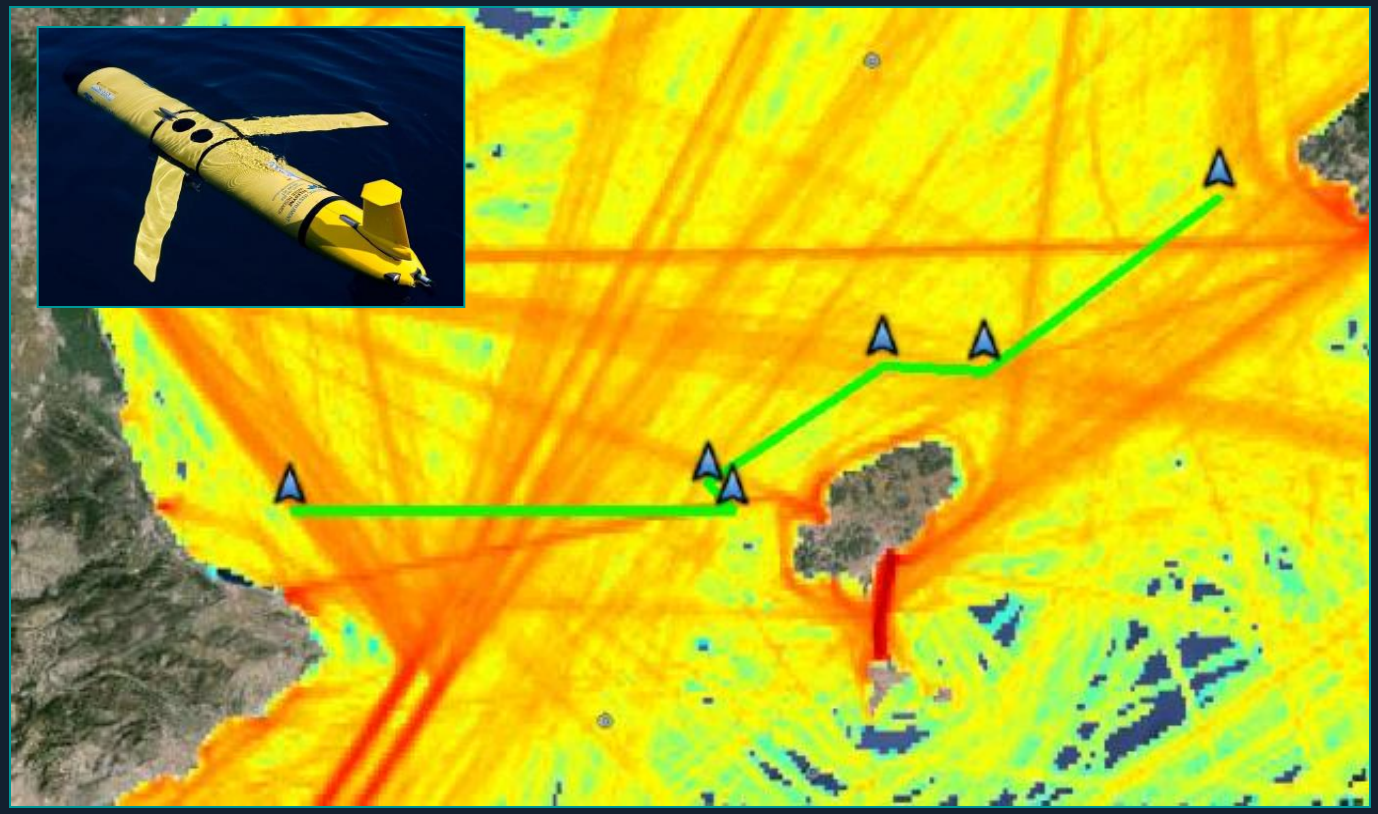
  Interpolation algorithms incorporate multidimensional data using hydrographic models provided by SOCIB

APPLICATIONS: OIL SPILL RISK



- Web-mapping application displays traffic density together with shoreline environmental sensitivity
  www.gis.socib.es/sacosta

APPLICATIONS: OCEANOGRAPHIC RESEARCH



- Planning glider campaign route

  Marine traffic density is used by SOCIB to plan the route of underwater autonomous vehicles (AUV)

APPLICATIONS: CUMULATIVE PRESSURES

HIGH-RESOLUTION CUMULATIVE PRESSURE ANALYSIS

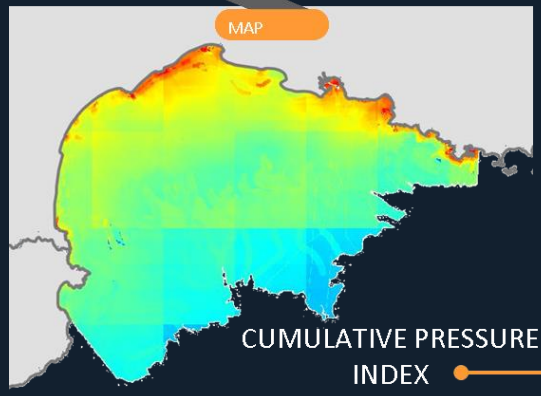
- 35 PRESSURE MAPS
- 16 ECOSYSTEM TYPES
- 35 x 16 VULNERABILITY MATRIX
- 750,000 GRID CELLS

MODELLING

TRANSFORMATION

NORMALIZATION

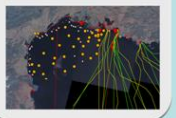
MAP



CUMULATIVE PRESSURE INDEX

HOW WE CALCULATE THE INDEX?

PRESSURES

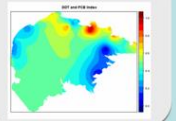


ECOSYSTEM MAP

ASSESSMENT UNIT 250x250 m

WEIGHT SCORES (u_{ij})

PRESSURE (P_i)



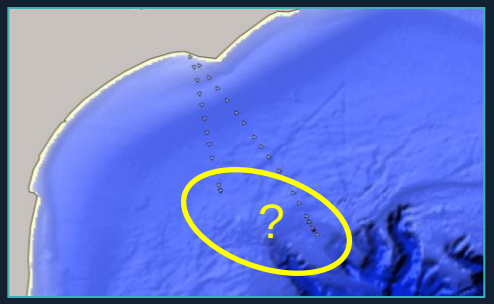
ECOSYSTEM (E_j)

CUMULATIVE INDEX

$$I = \sum_{i=1}^{n} \sum_{j=1}^{m} P_i \times E_j \times u_{ij}$$

Based on Halpern et al. 2008

LIMITATIONS AND FURTHER WORKS



- Combined monitoring

- Improve AIS coverage

- Open data availability

- Data-intensive tools

CONCLUSIONS

Automated Identification Systems and related technologies allows an unprecedented opportunity to monitor ship-based activities

Data-intensive tools allow the discovery of new science-based information

A better understanding of ship-based activity patterns will contribute to support the implementation of MSFD and MSP

THANK YOU FOR YOUR ATTENTION!

ACKNOWLEDGEMENTS

Marc Torner
Pau Balaguer
Benjamín Casas
SOCIB Data Centre
Carla Murciano
Joan Albaigés
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