Marine pollution monitoring, forecasting, and mitigating the impact on marine life and coastal populations
A clean ocean where sources of pollution are identified and removed.

Marine pollution monitoring, forecasting, and mitigating the impact on marine life and coastal populations.

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After “Future Plan for Ocean Research”
Hitoshi Hotta, Japan Agency for Marine-Earth Science and Technology, Oceans’12 Yeosu Korea

- Sensors, on-board systems, drones
- Multisource observations, data processing, communications
THE EARTH SYSTEM IS COMPLEX
OBSERVATIONS
MEASUREMENTS
ASSESSMENT OF EXISTING RELEVANT DATA

• Beach/shore line data
• Floating marine litter
• Marine litter in the water column
• Seafloor marine litter
• Ingested marine litter
• Sources of marine litter

River mouths: 90% of plastic flow in the ocean. Direct measuring concentration of plastic particles via in situ samples at water surface. Direct measurement of movements (remote sensing)

- In situ observations, field surveys, drones, crowdsourcing, webcam, …
- Indirect indicators: Coastal and watershed population, beaches physical characteristics
- Sea-based sources of plastic (ship traffic)
- Automated microplastics sensor for in-situ measurements.
- HF ground-based radar systems (network).
- Potential monitoring via satellites (space/time resolution!)

Based on “Technologies for Observing and Monitoring Plastics in the Oceans”, René Garello et al, OCEANS 2019 Marseille, June 2019
THE SENTINEL FAMILY

sentinel-6
sentinel-5
sentinel-5p
sentinel-4
sentinel-3
sentinel-2
sentinel-1
IN SITU PLASTIC MEASUREMENTS

Drones results for measuring plastic patches.

Imagery from a drone at 25m altitude captured around System001 in November 2018 by Robin de Vries

From Garaba, 2018
Use of litter-like transmitters for Plastic Marine Debris:

Coupling between global circulation/drift model and argos style positioning system
UNDERWATER IN SITU MEASUREMENTS

Common Sense project (Oceans of tomorrow).

odysseaplayerform.eu
BEACH/SHORELINE DATA

Ocean Conservancy TIDES data system

Collected during the annual International Coastal Cleanup and by users of Clean Swell, Ocean Conservancy's ocean trash data collection app
Lagrangian integration from annual Population Density
C-GLORSv5 - daily 1985-2013 - particles activated 20 years - frame 000

"This is not the « real » density of plastics floating in the ocean"

(From Maes et al., GRL, 2018)
MONITORING
UNDERSTANDING
MITIGATING
CHALLENGES

- How do we observe?
- How do we integrate?
  - Diversity of sources (above and below the surface, on the beach, models, …)
  - Diversity of communities (science, technology, citizens, regionally oriented, …)
  - Diversity of « data processing » (platforms, pre vs post processing, calibration, …)

- How do we manage?
  - Role of AI
Example for “marine debris”:
TOWARDS DETECTING FLOATING OBJECTS ON A GLOBAL SCALE WITH LEARNED SPATIAL FEATURES USING SENTINEL 2
Jamila Mifdal et al, φ-lab, European Space Agency, ESRIN

After “Machine Learning”, Dr. Lior Rokach, Ben-Gurion University
AI SUPERVISING THE LOOP

Numerical models

Earth monitoring

AI

TensorFlow
Floating marine debris along Indonesian coasts: An atlas of strandings based on Lagrangian modelling; Dobler et al., IRD

Manta project

https://www.thesearable.org/
Under GEO Blue Planet, an IEEE/OES funded working group on marine litter is investigating the sources, distribution and impact of marine debris, and supporting mitigation measures, policies and regulations to reduce it.
Over 1500 practices in the repository

Provides long-term sustainable BP access
SENSORS ON-BOARD

- Sentinel 1: imaging radar
- Sentinel 2: multispectral high-resolution imaging
- Sentinel 3: SST, SSH, ocean color
- Sentinel 4 & 5: atmosphere/ Met (aerosol, gases, …)
- Sentinel 6: Altimeter

See at: https://sentinels.copernicus.eu/web/sentinel/missions
Satellite remote sensing is only applicable for floating debris close to the surface

Imaging radars (SAR)
Provide high-resolution information on parameters of the ocean surface (topography, roughness, surface waves, winds and currents).
Correlates with the movement of marine debris, or identification of convergent fronts where floating debris collects.

-> Coupling with Ocean General Circulation Models.

Altimeters
Reconstructing the path of plastic from source to fate. Combined with auxiliary datasets such as currents, wind & waves
Multi/Hyper spectral and Ocean Color
Looking at anomalies or particular signatures to identify ocean plastics and large agglomerations of plastic. Problem: resolution.

Combine with airborne sensors or drones. Hyperspectral sensors such as HyMap may be more suited to detecting plastics, these are available commercially.

Direct tracking of plastic or floating pieces (GPS tags or transmitters).

-> KINEIS constellation (IoT technology, see at https://www.kineis.com/en/homepage/).
Problem: the caveat of introducing electrical trash into the environment.
THREE MAIN DRIVERS FOR AI

More Data
Better Models and Algorithms
Powerful GPU Accelerators

Especially for Deep Learning
THE FOURTH DRIVER

The designer

- A priori knowledge
- Data selection
- Data Filtering and Enhancing
- Model selection
- Learning technique choice
- Experiment Design
- Avoid brute force
- Hybrid systems
  - Divide et impera
WHAT AI IS NOT

Autonomous machine

“Intelligent” machine

I’m sorry Dave, I’m afraid I can’t do that.