Marine pollution and environmental Issues in the Gulf of Thailand

2024 SEAFDEC Training Program (2024-05-13)

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What is Pollution?

Environmental pollution, is the addition of any substance (solid, liquid, or gas) or any form of energy (such as heat, sound, or radioactivity) into the environment at a rate faster than it can be dispersed, diluted, decomposed, recycled, or stored in some harmless form.

Marine Pollution, is the addition of any substance or any form of energy into the MARINE environment at a rate faster than...

*~80% of marine pollution comes **from land-based sources***

https://www.britannica.com/science/pollution-environment

https://pngtree.com/freepng/pollution-of-gas-pollution-water-plant_3148580.html

http://static1.squarespace.com/static/55c9eab7e4b080aed53aafb2/t/55ebd9d8e4b08279fc0b8a03/1441520106932/?format=1500w

Where does pollution come from?

Although environmental pollution can be caused by natural events such as forest fires or active volcanoes, pollution generally implies that the contaminants have an **anthropogenic** source - that is, created by human activities

pollution can be visible and it can be invisible

http://www.theplaidzebra.com/wp-content/uploads/2015/04/2_villagers-live-volcano.jpg

Major categories of pollution

1. **Air** Pollution
2. **Land** Pollution
3. **Light** Pollution
4. **Noise** Pollution
5. **Thermal** Pollution
6. **Visual** Pollution
7. **Water** Pollution

Air

http://www.visiontimes.com/uploads/2015/01/Benxi_Steel_Industries.jpg

Land

https://pixfeeds.com/images/18/469117/1200-597647534-land-pollution.jpg

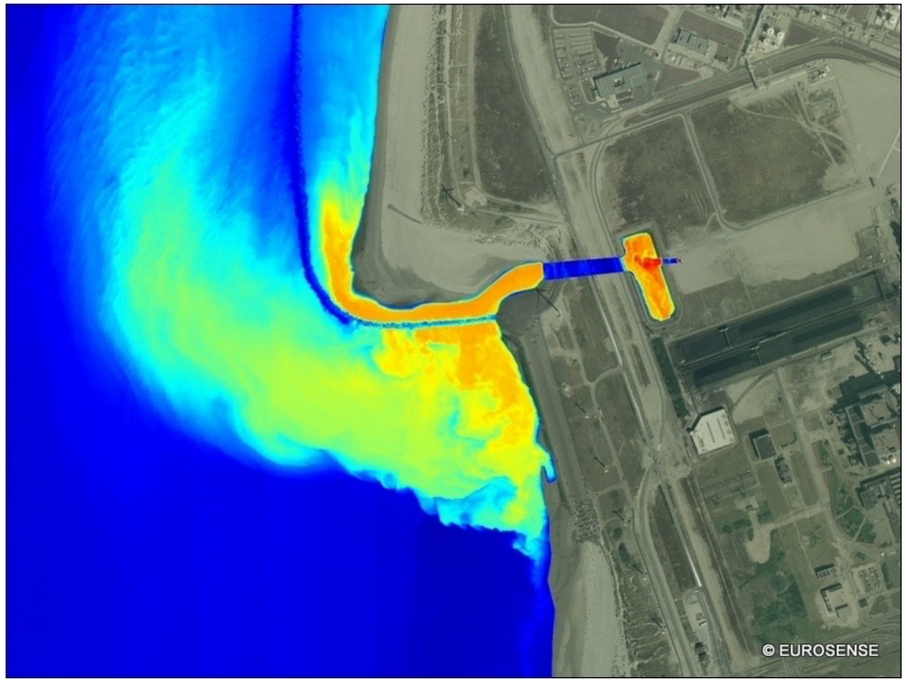
Light

http://penguinsix.com/wp-content/uploads/2012/04/lightpollute.png

Noise

https://www.citypassguide.com/media/slideshow/noise-pollution-1.jpg

Thermal



http://www.eurosense.com/documents/graphics/images/your-application/water-management/hot_water_distribution_maasvlakte_eurosense_b.jpg

Visual

https://understandingpollution.files.wordpress.com/2014/12/visual-pollution-2.jpg

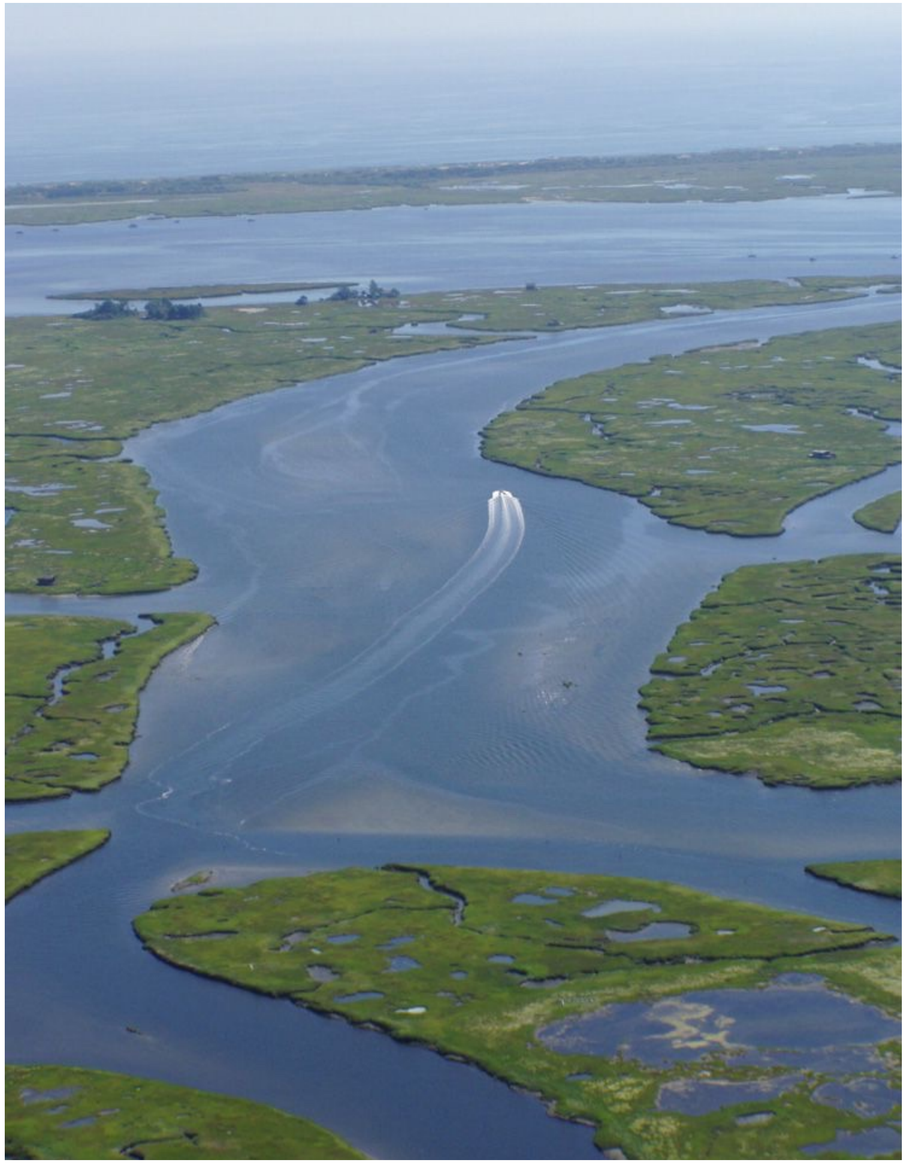
Water

http://cdn.yourarticlelibrary.com/wp-content/uploads/2013/12/b957.jpg

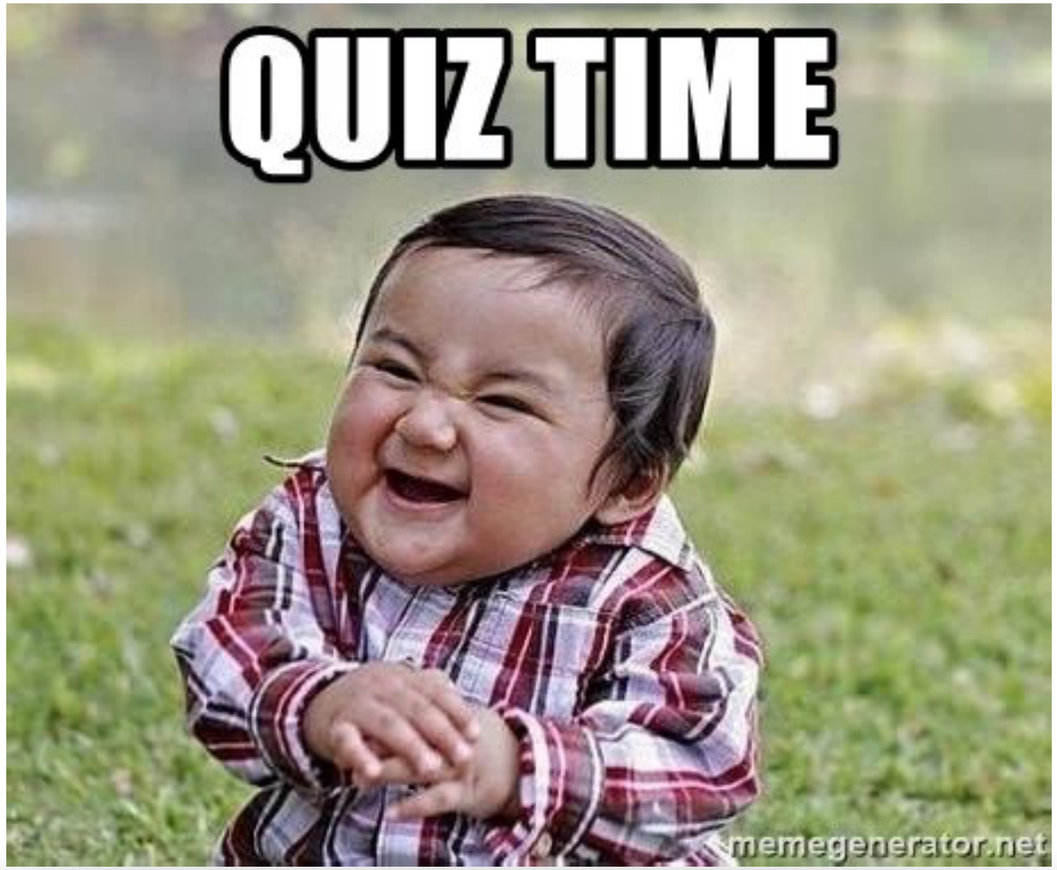
The Marine Environment

- The Ocean
- Estuaries

An **estuary** is an area where a freshwater river or stream meets the ocean. In estuaries, the salty ocean mixes with a freshwater river, resulting in **brackish water**. Brackish water is somewhat salty, but not as salty as the ocean.



https://www.nationalgeographic.org/encyclopedia/estuary/



How many different categories of <u>marine</u> pollution can you identify?

Major sources of marine pollution

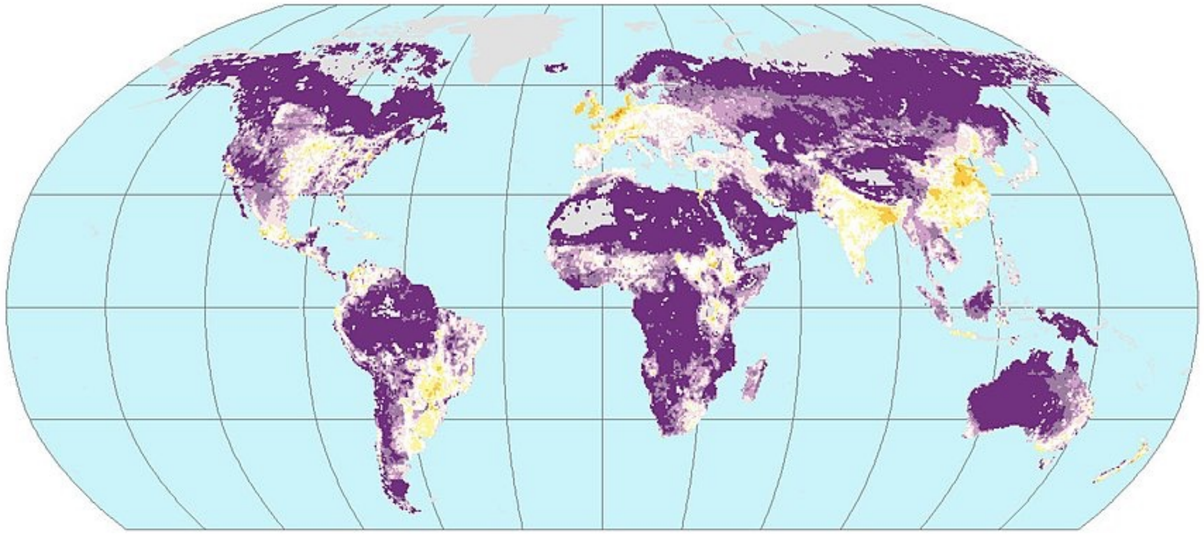
- Nutrients
- Marine Debris
- Oil & Related Chemicals
- Metals
- Pesticides and Industrial Organic Chemicals
- Emerging concerns
- Bioaccumulation & Biomagnification
- Climate Change & Ocean Acidification
- Biological Pollution

https://www.greenpeace.org/international/story/44923/oil-is-leaking-all-over-the-world/

https://1.bp.blogspot.com/-_FDct7fdcfM/VsMKlsbumZI/AAAAAAAAAK4/iBIQt1xQVWU/s1600/ocean%2Bpollution.jpg

Global Nitrogen Fertilizer Application

Global Fertilizer and Manure, Version 1



Robinson Projection

Amount of nitrogen fertilizer applied averaged over all crops within the 0.5 deg grid cell. Grid cell values are expressed in kilograms per hectare (kg/ha) ranging from 0 to 370. The data values were computed by fusing global maps of harvested areas for 175 crops with national information on fertilizer use for each crop.

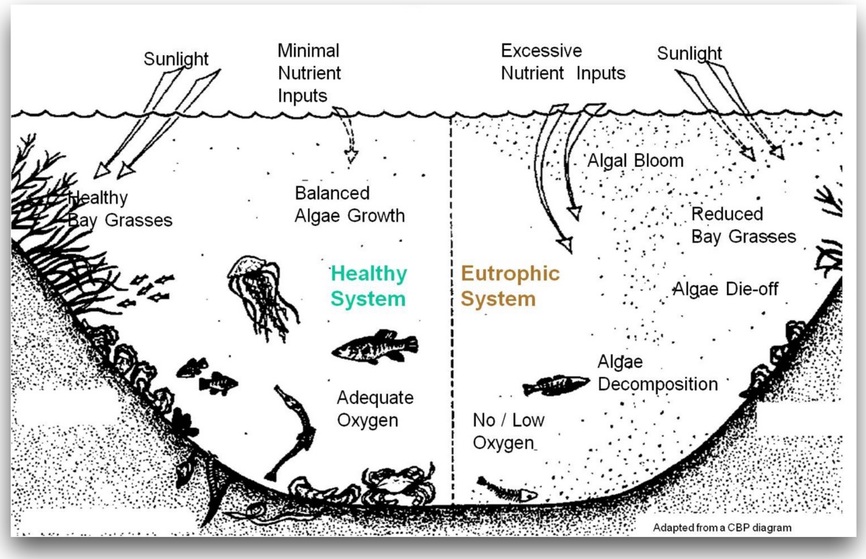
Kg/ha of Nitrogen Fertilizer applied per grid cell:

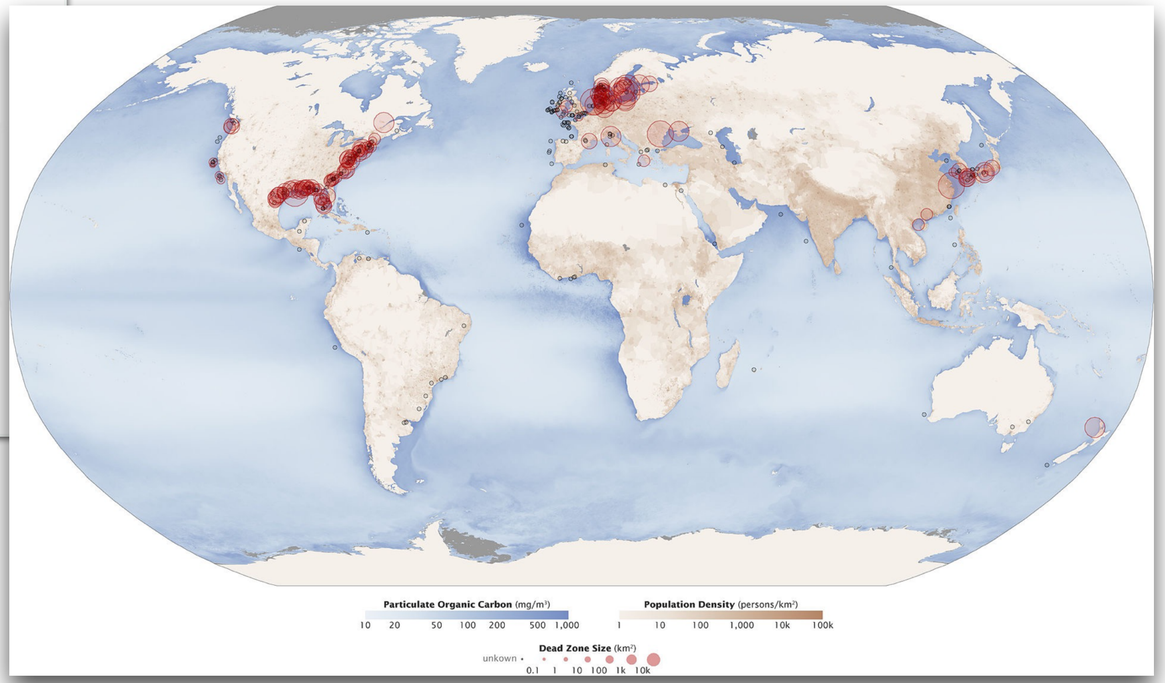
Publication Date: 1/24/2011

Center for International Earth Science Information Network
EARTH INSTITUTE | COLUMBIA UNIVERSITY

Source: Potter, P., and N. Ramankutty, et al. (2010). Global Fertilizer Application and Manure Production.
Data distributed by the NASA Socioeconomic Data and Applications Center (SEDAC): http://sedac.ciesin.columbia.edu/data/collection/fertilizer-and-manure

http://sedac.ciesin.columbia.edu/downloads/maps/ferman-v1/ferman-v1-nitrogen-fertilizer-application/nitrogen-fertilizer-global.jpg





https://gulfenvironmentnews.files.wordpress.com/2014/10/aquatic_dead_zones.jpg

NUTRIENT

https://www.dailypioneer.com/2019/trending-news/scientists-track-indian-ocean-s--missing--plastic-waste.html

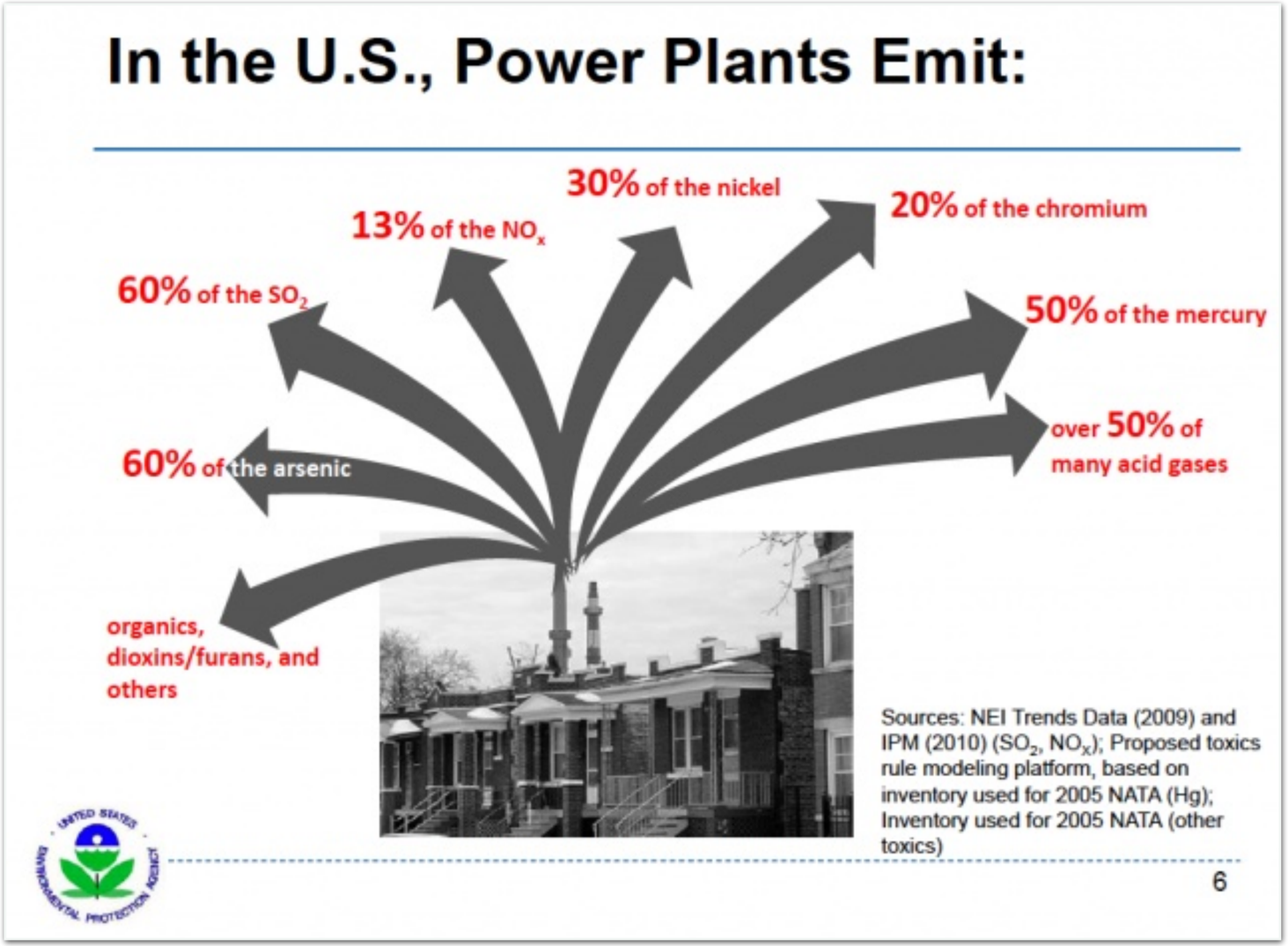
MARINE DEBRIS

https://oxfamblogs.org/fp2p/wp-content/uploads/2014/06/BP-oil-spill.jpg

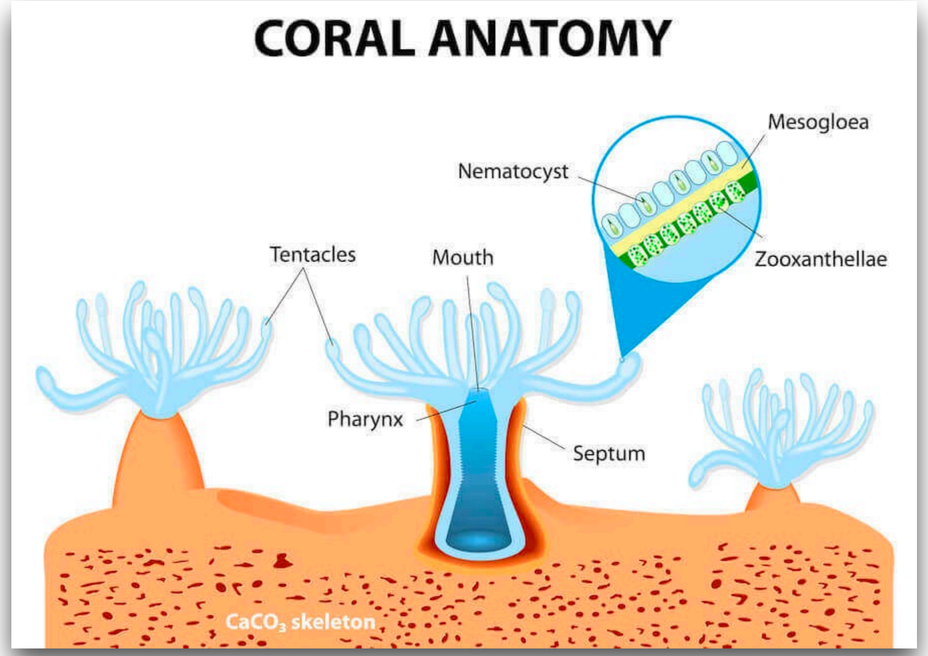
https://fortunedotcom.files.wordpress.com/2015/01/ap10060312648.jpg?quality=80

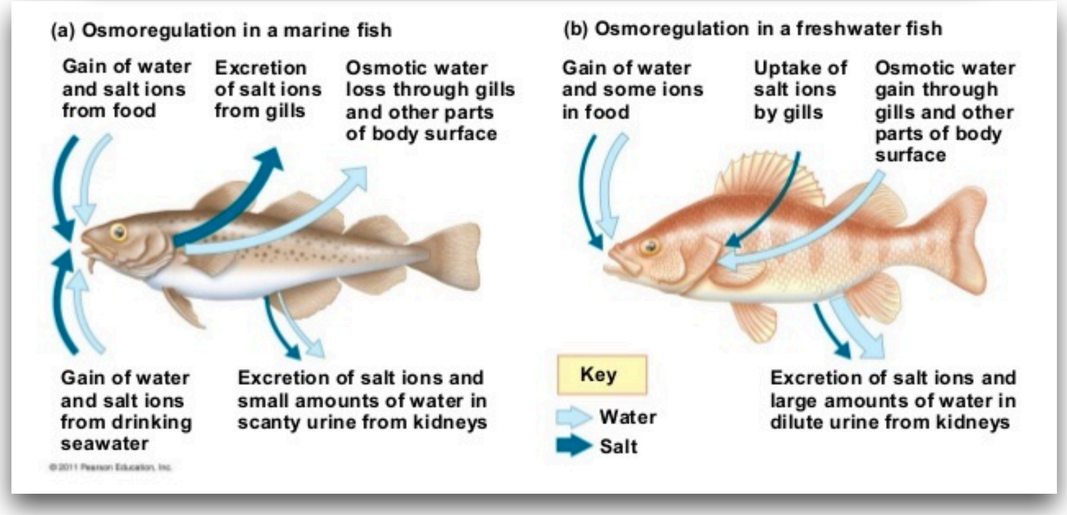
http://www.gannett-cdn.com/-mm-/a1059ca0bfe0aeb953c0a2a7e5690c5ed92b30f9/c=0-132-4746-2813&r=x1683&c=3200x1680/local/-/media/2015/05/21/USATODAY/USATODAY/635678380139028553-AP-California-Oil-Spill.3.jpg

OIL & RELATED CHEMICALS

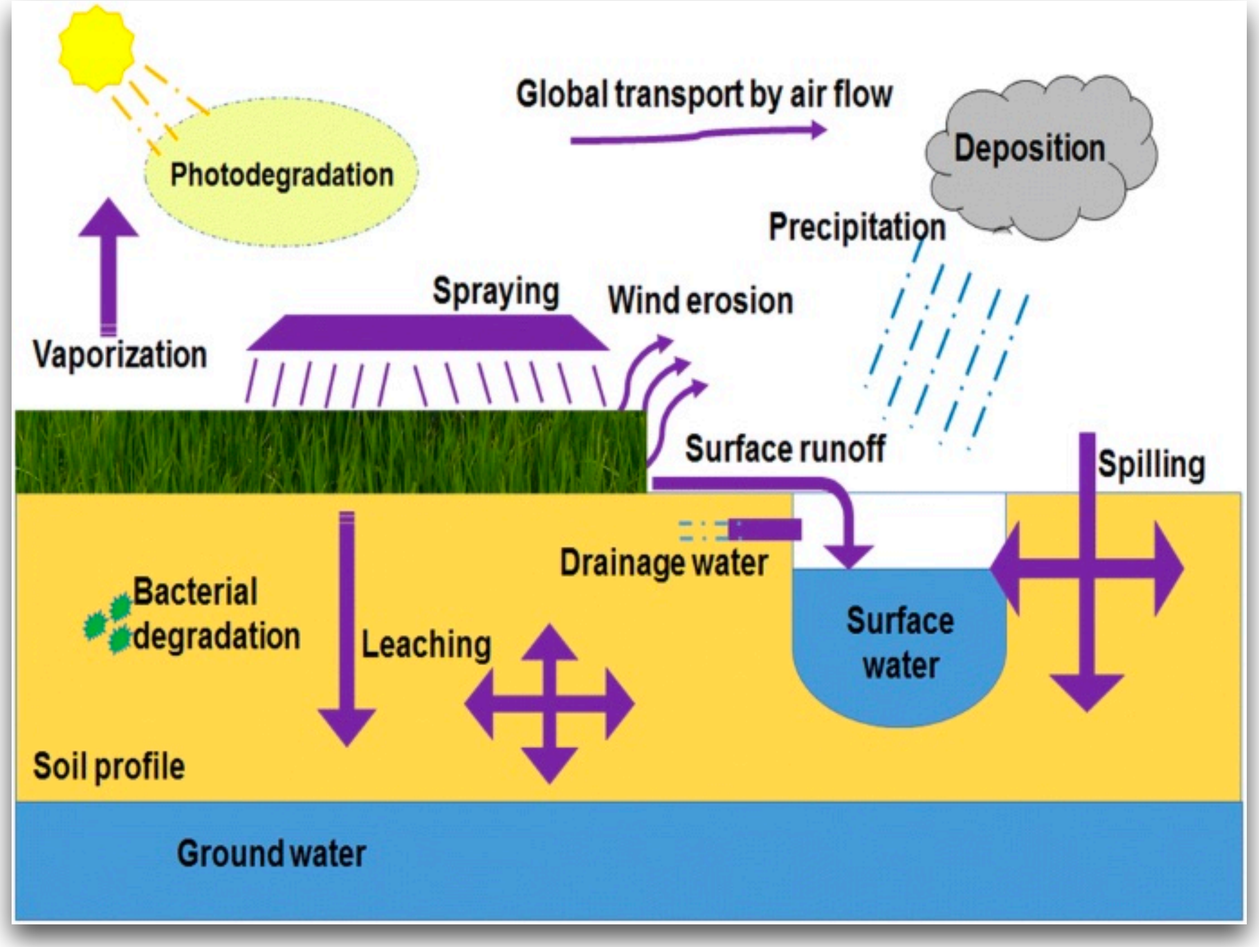


http://crooksandliars.com/files/imagecache/node_primary/primary_image/16/03/epa_power_plants.png





(HEAVY) METALS



PESTICIDES & INDUSTRIAL ORGANIC CHEMICALS

ASIA PACIFIC

The New York Times

SUBSCRIBE FOR $0.50/WEEK

In the Pacific, Outcry Over Japan's Plan to Release Fukushima Wastewater

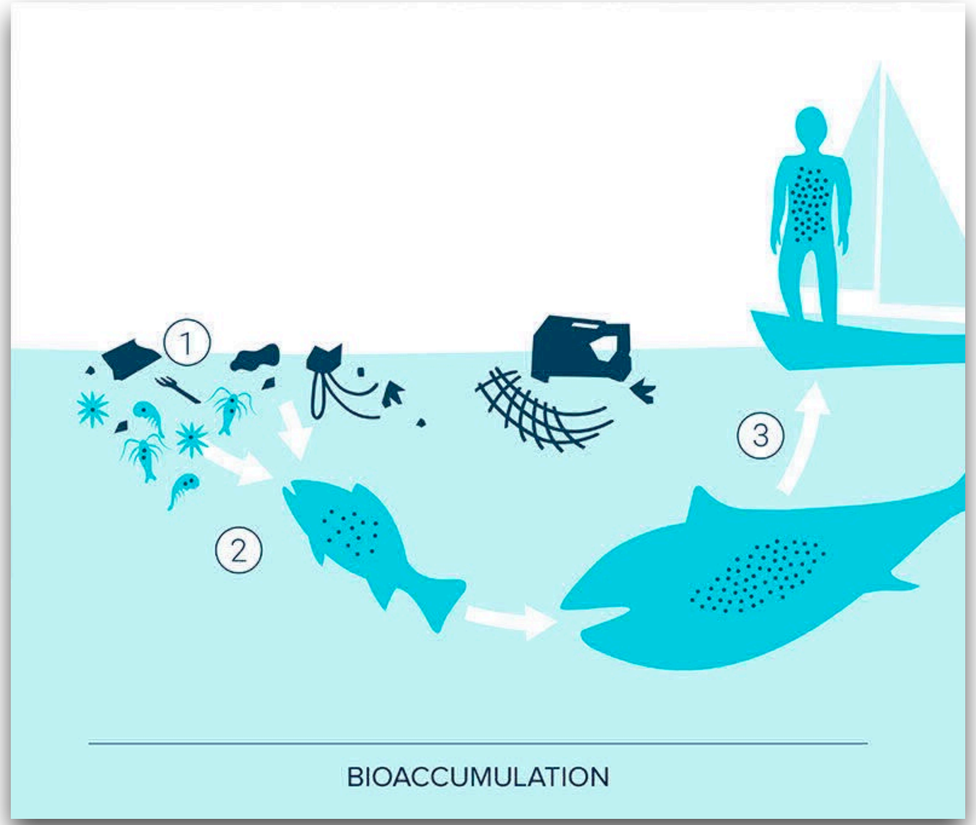
The proposal has angered many of Japan's neighbors, particularly those with the most direct experience of unexpected exposure to dangerous levels of radiation.

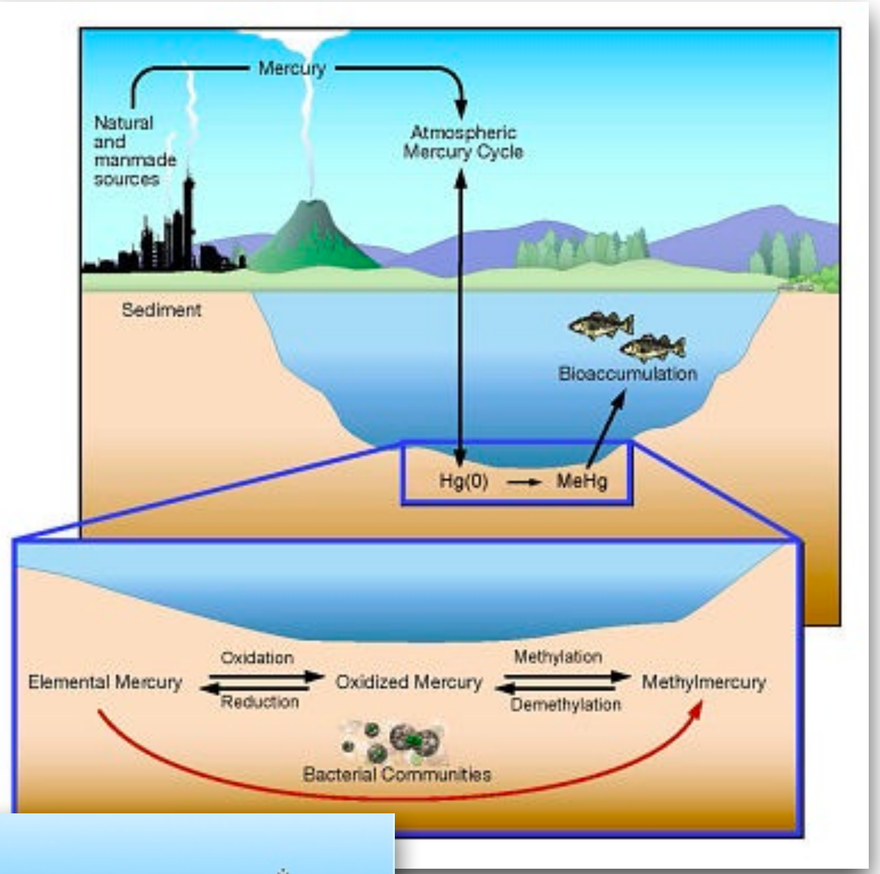
Give this article

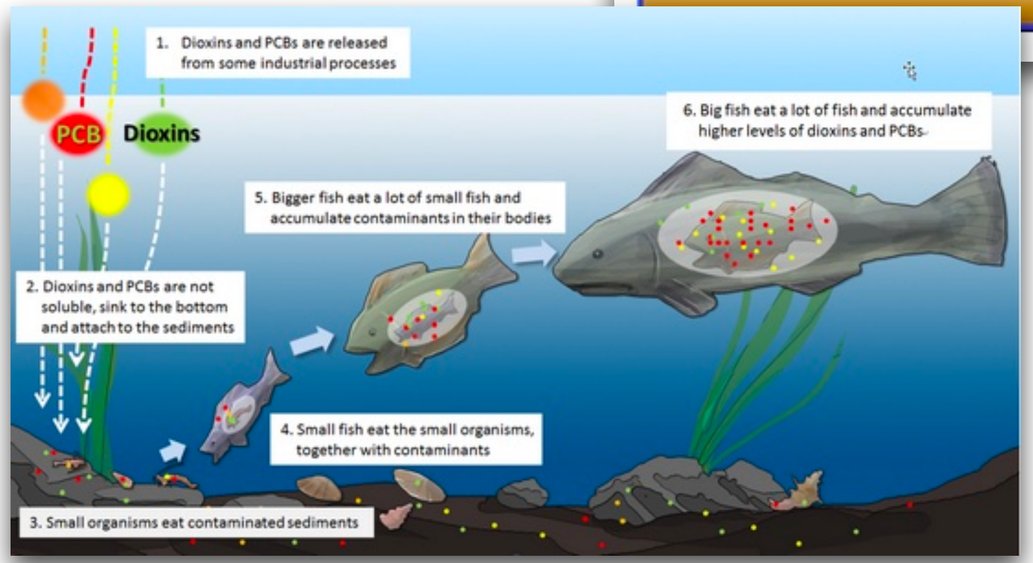
Tanks storing radioactive water at the Fukushima Daiichi nuclear power plant in Japan. The government plans to release the water, treated, but still slightly radioactive, into the Pacific starting in spring 2023. Ko Sasaki for The New York Times

By Pete McKenzie
Dec. 30, 2022

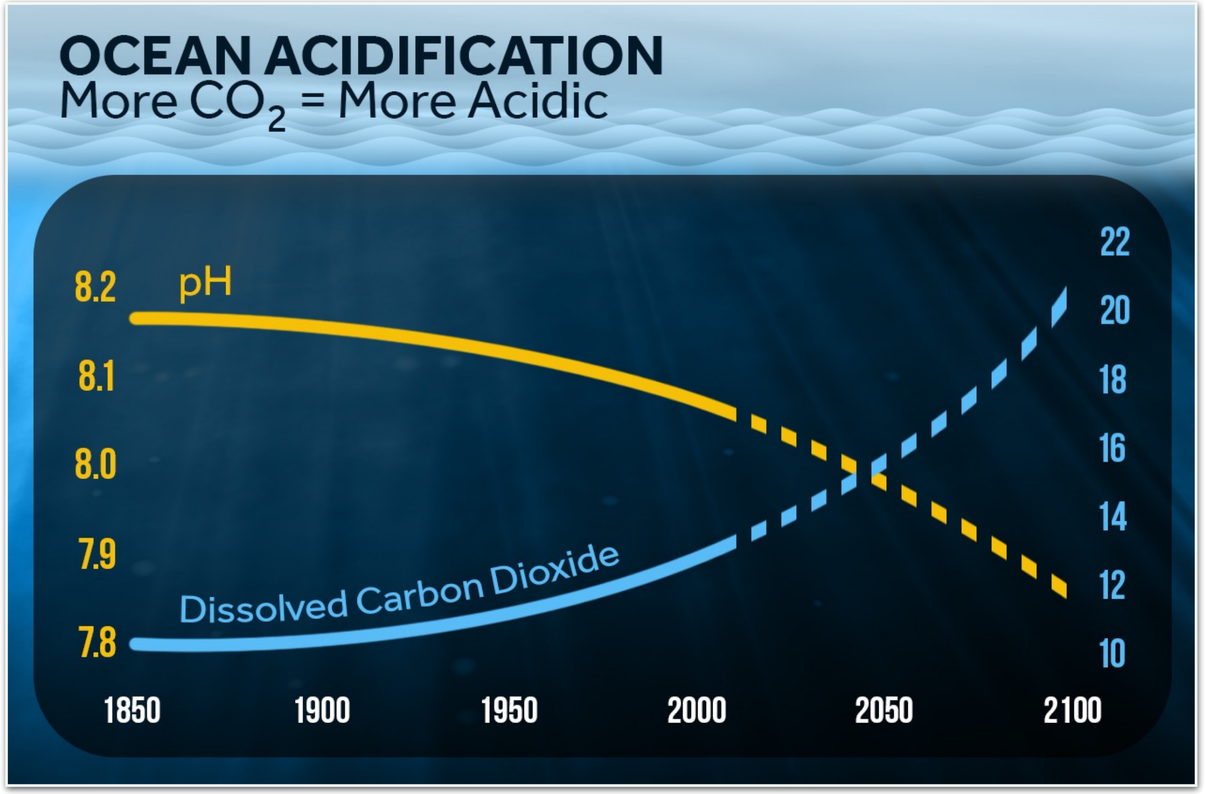
EMERGING CONCERNS



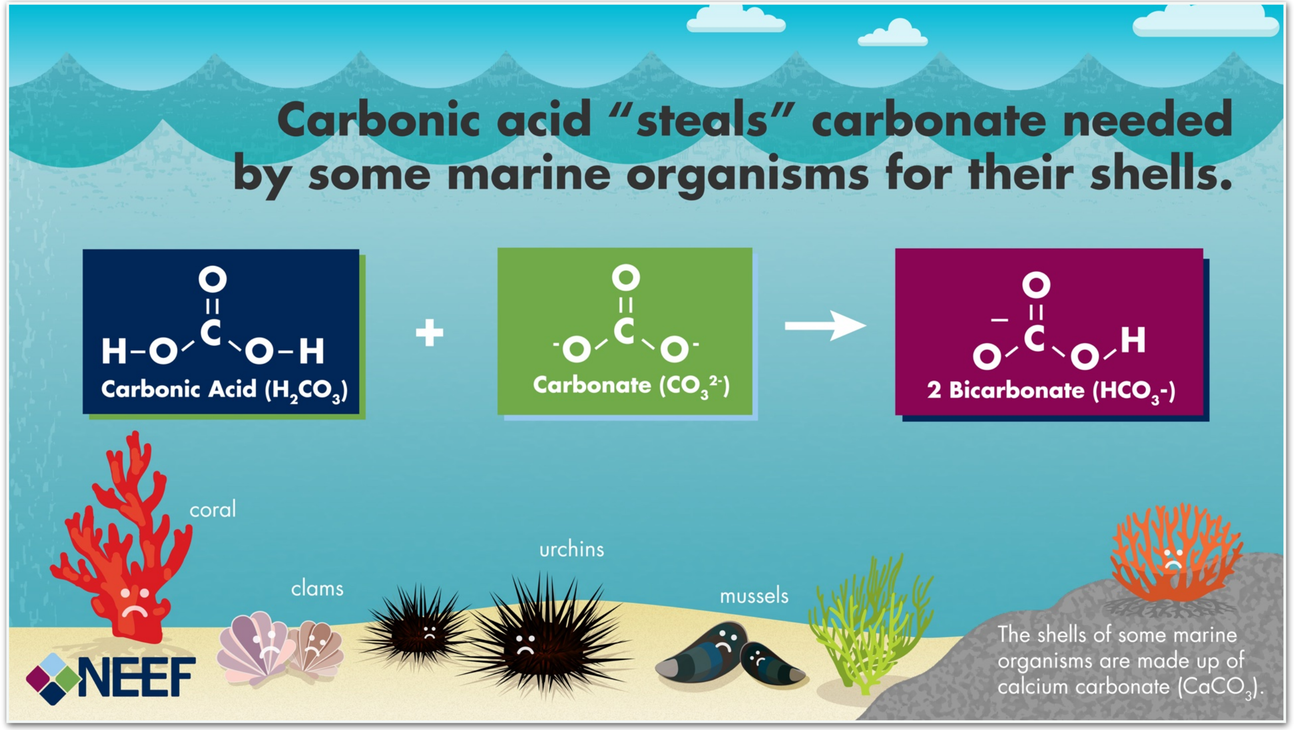




BIOACCUMULATION & BIOMAGNIFICATION



http://ccimgs.s3.amazonaws.com/2015OceanAcidification/2015OceanAcidification_CO2Graph.jpg



https://www.epa.gov/sites/production/files/2016-11/ocean_acidification_2.jpg

CLIMATE CHANGE & OCEAN ACIDIFICATION

http://mediad.publicbroadcasting.net/p/northwestnews/files/styles/x_large/public/201405/052914TB_TsunamiDebris.jpg

BIOLOGICAL POLLUTION

Why do we need healthy marine ecosystems? (1)

Coastal habitats account for ~30% of all marine biological productivity

Estuarine systems (salt marshes, seagrasses, mangrove forests) are some of the most productive regions on the planet

https://natgeoeducationblog.files.wordpress.com/2016/10/belize-mangroves.jpg?w=1200

Why do we need healthy marine ecosystems? (2)

Some marine ecosystems (coral reefs) provide food and shelter to the greatest amount of marine biological diversity in the world

The ocean plays a key role in the cycles of carbon, nitrogen, phosphorus, and other important chemicals

https://media.nationalgeographic.org/assets/photos/000/289/28979_r646x485.jpg?6f324ede0d87396ce502b4d0ba86a86f23ea2d88

What services do marine ecosystems provide us with?

- **Ecological**
- Climate moderation
- CO_2 absorption
- Nutrient cycling
- Water treatment
- Reduced storm impact (wetlands)
- Habitat
- biodiversity

- **Economic:**
- Food
- Medicine (coral reefs)
- Transportation
- Habitat for humans (coastal)
- Employment
- Oil/gas
- minerals

Ecosystem Services

Declining health of our marine ecosystems (1)

Ocean chemistry has been changing due to human activities - both in coastal waters and in the open ocean

Some of the greatest impacts are on **carbon, nitrogen** and **dissolved oxygen,** which affect biological functioning

Decades of **marine pollution**, along with **destruction of coastal habitats** and **overfishing**, have had devastating impacts on marine biodiversity and habitats

https://draggarwal.files.wordpress.com/2012/05/582323-26.jpg?w=604

Declining health of our marine ecosystems (2)

The ever-**increasing demand for seafood** worldwide has depleted many fish populations, along with the economies of some coastal communities

Climate change is altering the oceans in ways that we are just beginning to understand

http://thankyouocean.org/wp-content/uploads/2015/12/sea-of-hooks.png

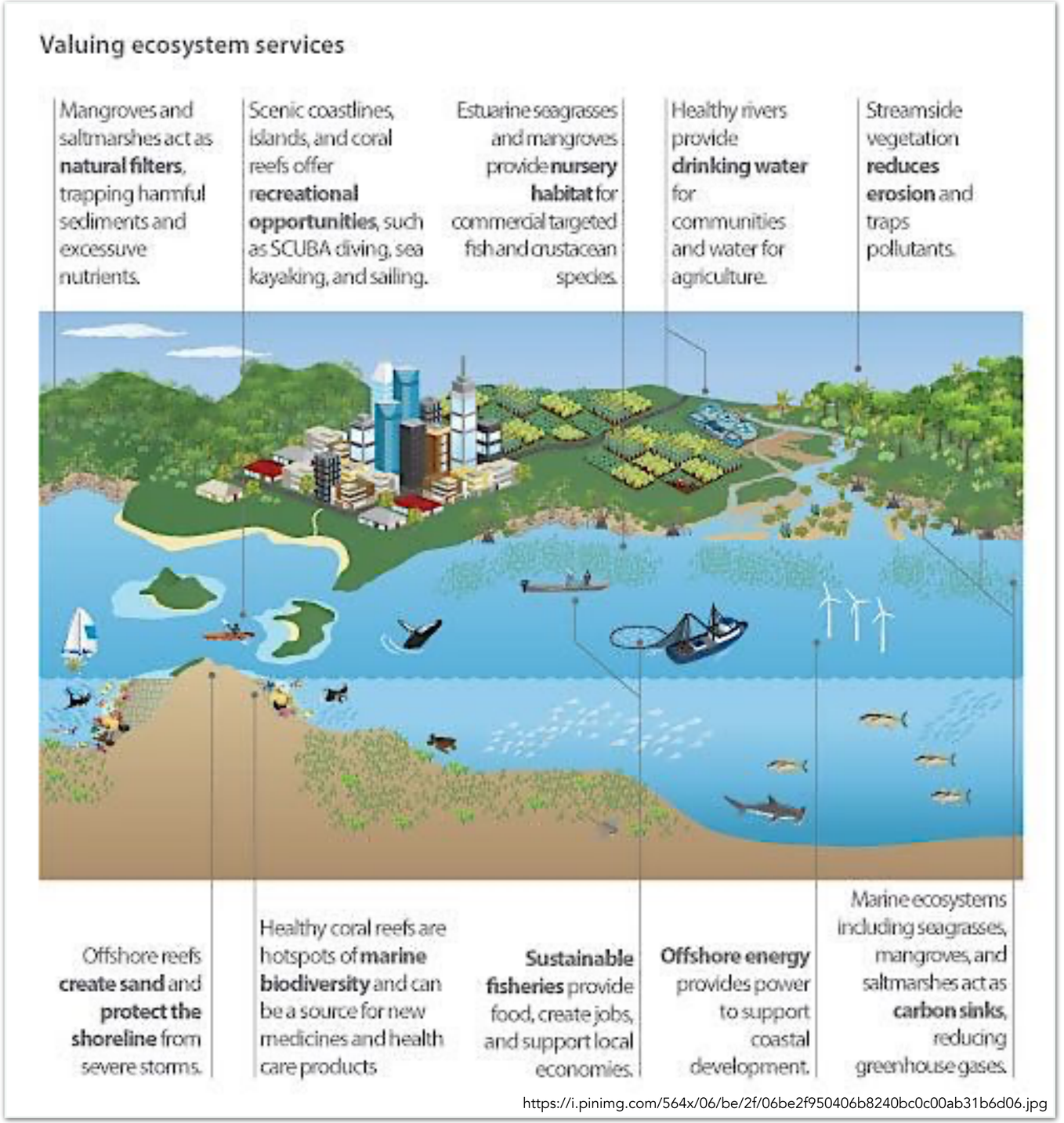
Declining health of our marine ecosystems (3)

The pollutants of greatest concern are those that are **widespread** and **persistent** in the environment, **accumulate** in organisms, and cause effects at **low concentrations**

http://www.seychellesnewsagency.com/media/images/2017-02/photo_verybig_6788.jpg

Ecosystem services

Ecosystem services are the many and varied benefits that humans freely gain from the natural environment and from *properly-functioning* ecosystems.



https://i.pinimg.com/564x/06/be/2f/06be2f950406b8240bc0c00ab31b6d06.jpg

No ocean, no life.

No ocean, no us.

Sylvia Earle

Marine Pollution in Thailand

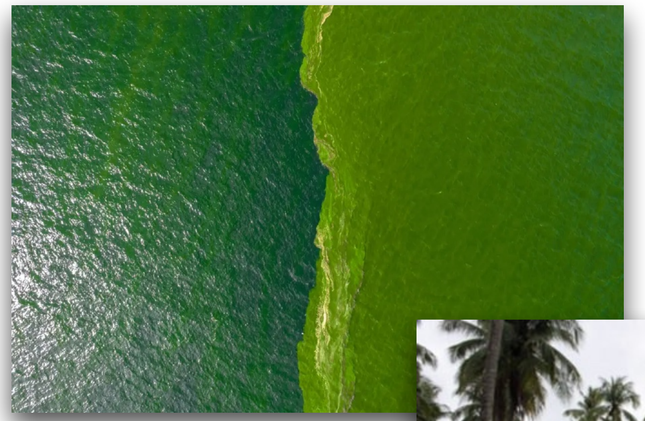
The Gulf of Thailand

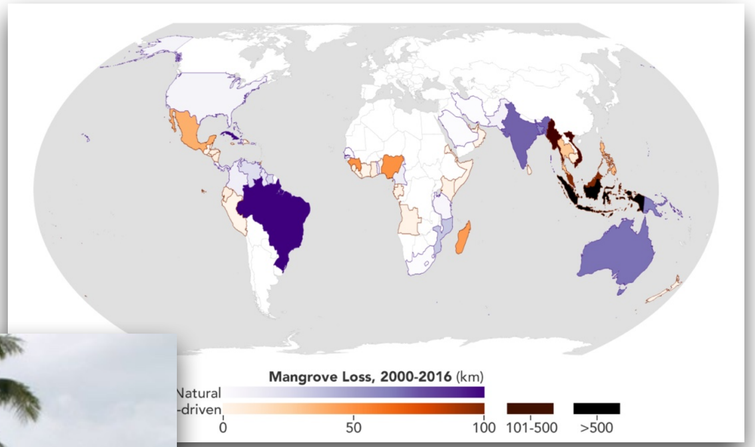
- The Gulf of Thailand is one of 21 enclosed coastal seas as identified by the International EMECS Center
- The gulf is located in Southeast Asia, immediately to the west of the South China Sea
- It is bordered by 4 nations: Thailand, Cambodia, Malaysia and Vietnam
- Millions of people derive their livelihoods from the fish and marine resources obtained from the gulf
- Millions more people are directly affected by any changes in the gulf environment

https://www.google.com/maps/place/Gulf+of+Thailand/@9.00953,97.8254186,6z/data=!4m6!3m5!1s0x30556d048276d88f:0x2a0223bc562eaf80!8m2!3d9.7121198!4d101.3431058!16zL20vMDFjNGR6?entry=ttu

Major Marine Pollution and Environmental Issues in the Gulf of Thailand

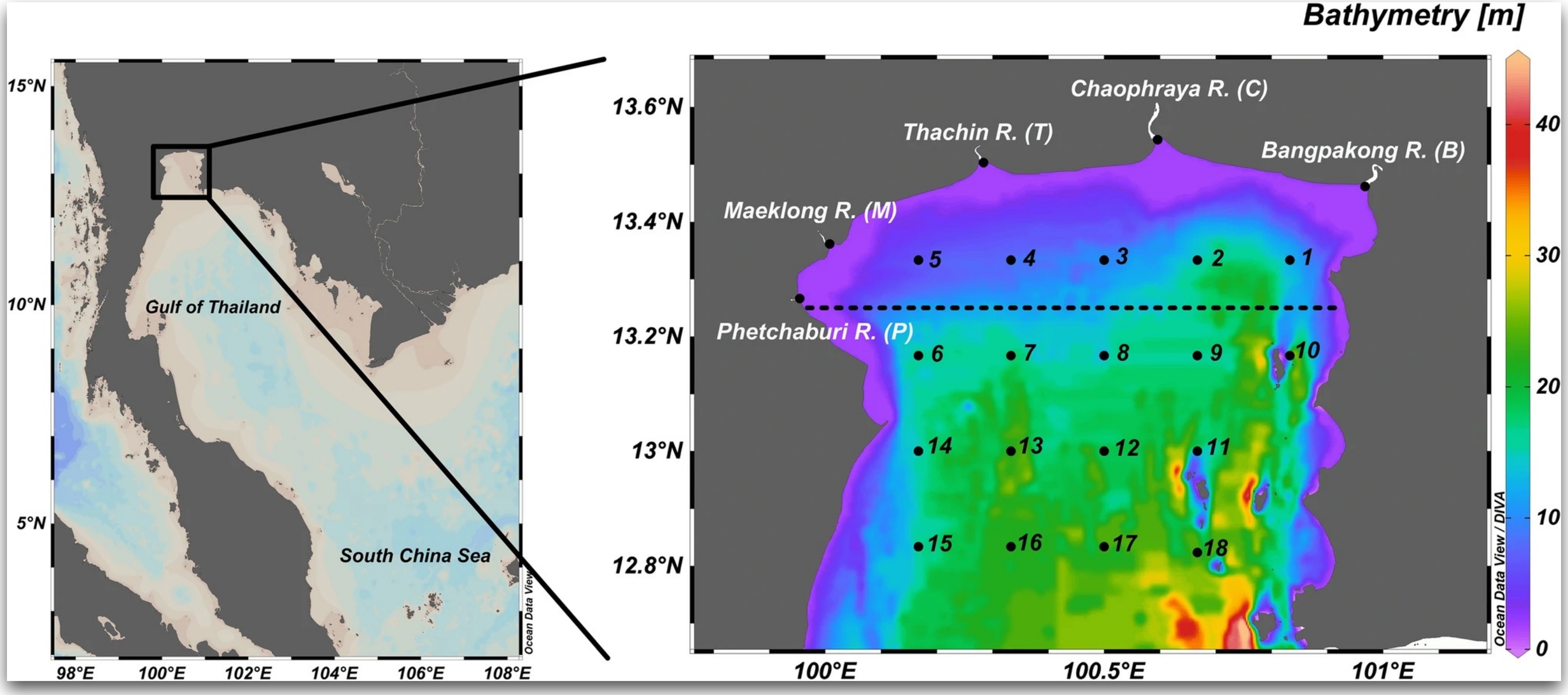
1. Eutrophication
2. Mangrove conversion and destruction
3. Persistent Chemicals
4. Coastal Erosion
5. Marine Litter (Debris)





https://www.nasa.gov/centers-and-facilities/goddard/nasa-study-maps-the-roots-of-global-mangrove-loss/

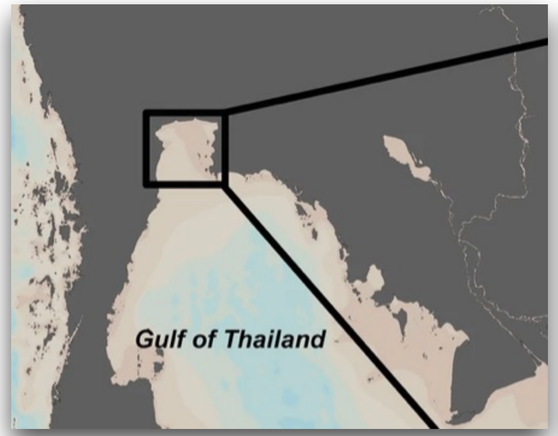
Gulf of Thailand (Inner Gulf)

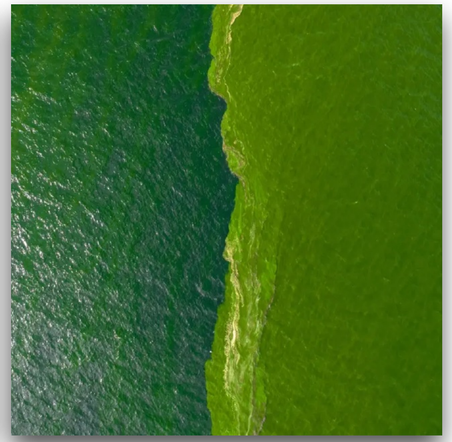


https://link.springer.com/article/10.1007/s10872-021-00609-2

Eutrophication

- Of all the rivers draining into the Gulf of Thailand, the Chao Phraya is the most polluted, especially in the estuary area, due to urban and industrial expansion
- The major pollutants are degradable organic wastes, the most common effects of which are increased oxygen demand, input of pathogens, increased turbidity, nutrient enrichment (eutrophication)
- Since the upper gulf is semi-enclosed, the wastes from all these rivers to be retained and accumulate
- Decomposition of the organic wastes can rapidly cause algal blooms (red tides)





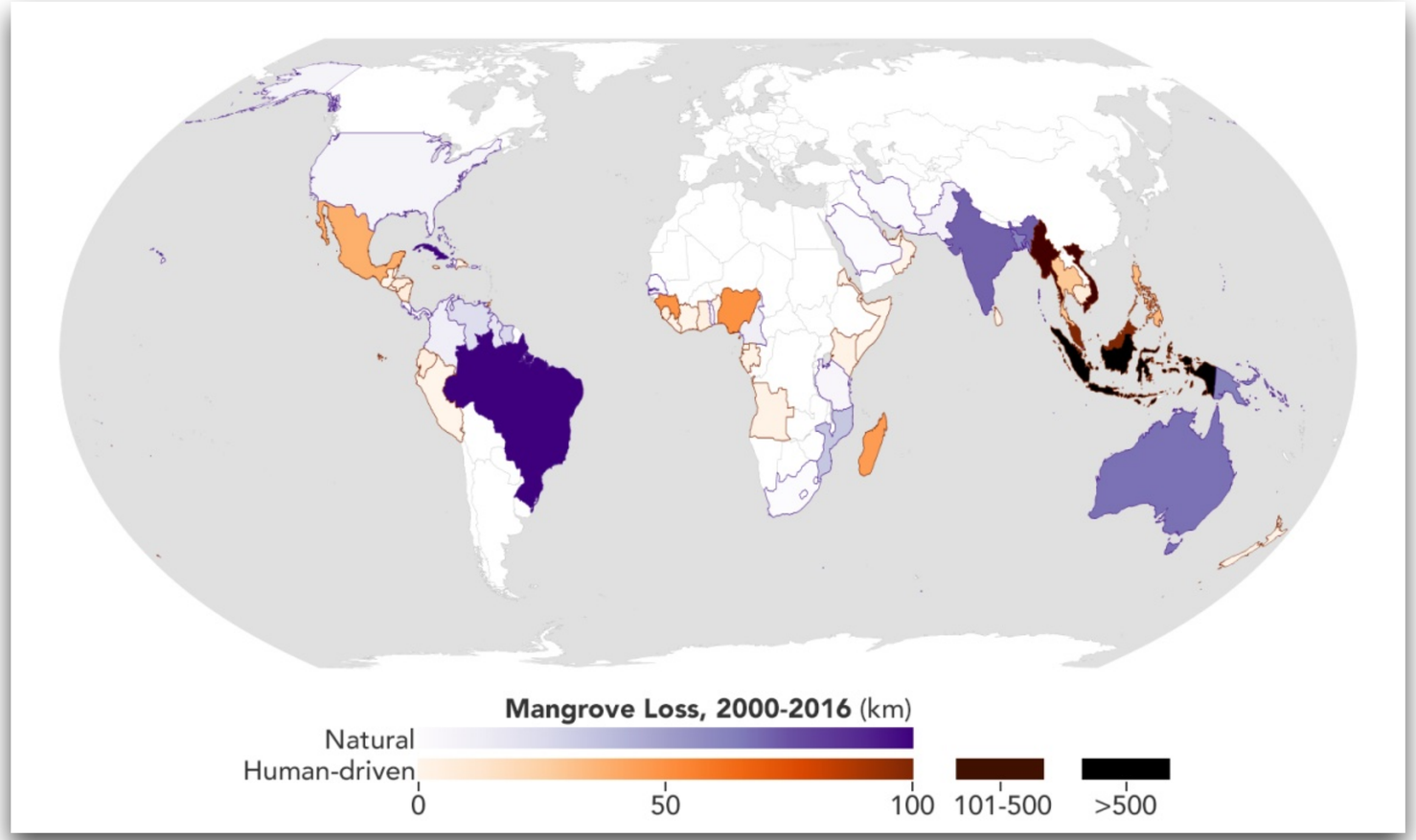
Plankton infests Rayong beach waters

PUBLISHED : 4 OCT 2022 AT 06:00
NEWSPAPER SECTION: NEWS WRITER: APINYA WIPATAYOTIN

Algal bloom is seen along a 3-km stretch of the coast in Rayong, emitting a foul odour. (Photo by Department of Marine and Coastal Resources)

Mangrove conversion and destruction

- Conversion of mangrove habitats to other uses: including rice paddies, coconut plantations, fish and shrimp ponds, salt evaporation ponds, urban sites, land fills and industrial development
- Over-exploitation of mangrove habitats for timber, fuel wood, and charcoal
- Insufficient mangrove recovery management including replanting after clear cutting for wood products

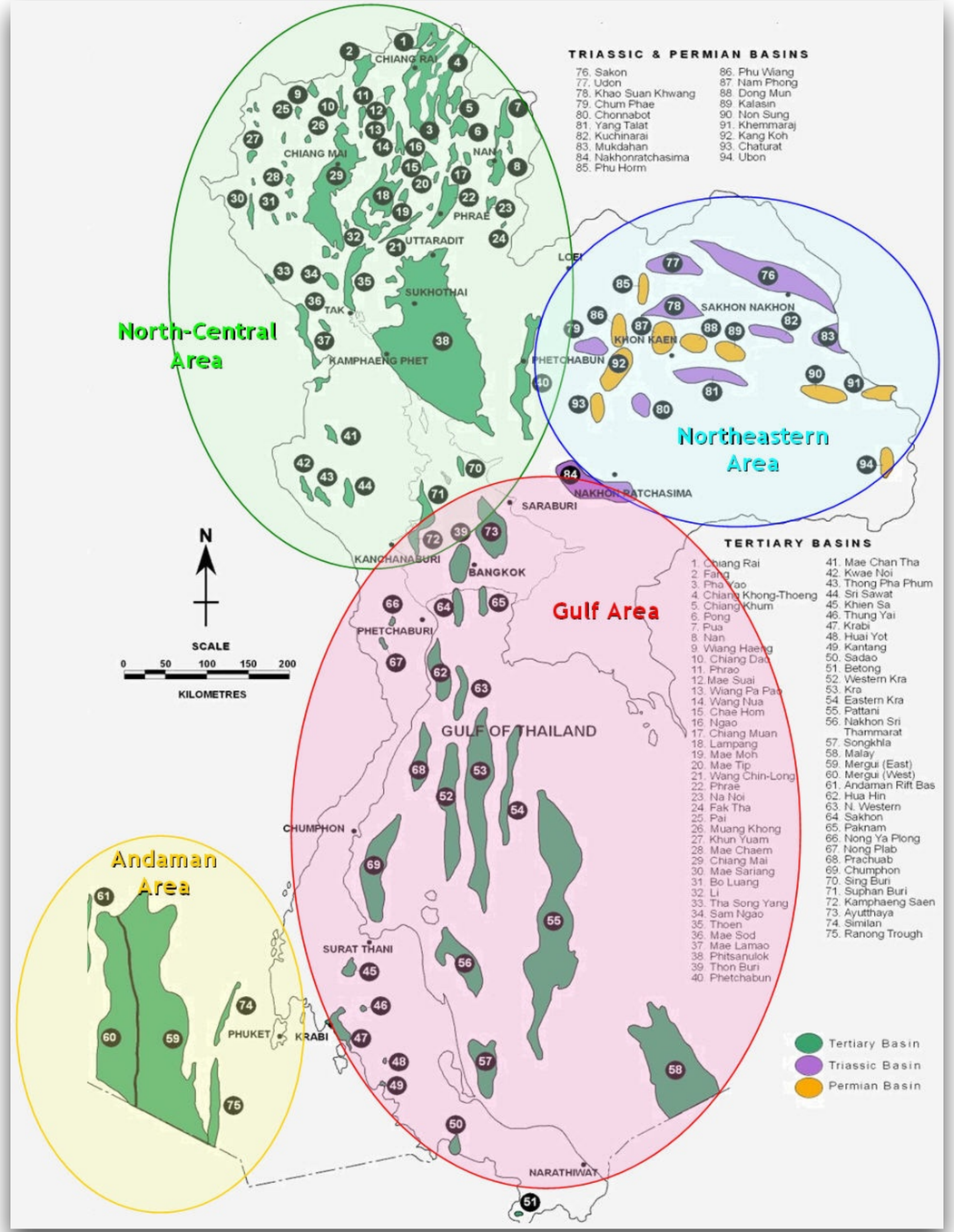


https://www.nasa.gov/centers-and-facilities/goddard/nasa-study-maps-the-roots-of-global-mangrove-loss/

Persistent Chemicals

- Thailand is an oil and natural gas producer. Most of the country's crude oil and condensates are from offshore fields in the Gulf of Thailand.
- Oil spills and other forms of marine pollution regularly occur along oil transportation routes where oil tankers load and offload and where petroleum companies operate, particularly in the Gulf of Thailand.
- Since 1974, there have been at least 240 oil spill incidents in Thai waters.

https://www.greenpeace.org/southeastasia/story/45124/thailands-oil-pollution-at-sea-the-fossil-fuel-industrys-liability/



https://www.dmf.go.th/bid20/images/001.jpg

Coastal Erosion

- Thailand has more than 3,000 km of coastline covering 23 provinces and over 800 km of that coastline are currently suffering from sea erosion
- Some of the erosion is caused by inappropriate activity in coastal areas such as building construction, changing mangrove forests to shrimp farms, industrial development, and activities that can cause soil subsidence like water pumping and soil scooping
- Other natural causes such as waves, strong tides and storms also cause erosion

Solving the Problems of Erosion on the Thai Coast

https://www.huahintoday.com/thailand-news/solving-the-problems-of-erosion-on-the-thai-coast/

Marine Litter (Debris)

- Marine debris can have an impact on ecosystems, fisheries, aquaculture, human health, and food safety.
- Incidents of entanglement and ingestion have been widely reported for a variety of marine mammals, reptiles, and birds that lead to chronic injury and death.
- Marine debris is also obviously found in shallow coral reefs through the influence of winds and tidal currents, which cause the extensive damage to reefs.

https://www.thailand.go.th/issue-focus-detail/001_04_027

https://news.cornell.edu/stories/2018/01/oceanic-plastic-trash-conveys-disease-coral-reefs

Marine Litter (Debris)

- Thailand has been ranked as the sixth worst contributors of marine debris in the world.
- Many varieties of coastal debris can be found along Thai coastlines, and the coastal debris distribution is related to economic activities in the area.
- Majority of coastal debris found include plastic bottles, caps, lids, food and beverage containers, rubber bands, and cigarette butts.

https://southeastasiaglobe.com/saving-koh-samui/

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Microplastic contamination in edible marine fishes from the upper Gulf of Thailand

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ARTICLE INFO

Keywords:
Marine plastics debris
Marine contamination
Exposure assessment
Health impacts

ABSTRACT

Seafood consumption is a major source of microplastic exposure for humans. Here, we demonstrated microplastic contamination in marine food fishes from the upper Gulf of Thailand. Microplastics were found in gastrointestinal tracts of 46.9 % of fishes sampled, with a mean concentration of 1.6 ± 0.5 pieces per fish or 0.04 ± 0.01 pieces/g of fish tissue. Demersal fishes had higher contamination rates than pelagic fishes. Fibrous-type and blue-colored materials were the most abundant microplastics, while the most common polymers were polyester and polyethylene. No associations between microplastics and histopathological changes were detected. Estimated daily microplastic exposure for human marine fish consumers was 0.03 to 0.1 pieces per person. Although we expect a low risk of microplastic contamination in fish muscle because of very low calculated transfer rates, we recommend continuing surveillance, including evaluations of contamination in the food chain to ensure future seafood safety in this region.

ABSTRACT

Seafood consumption is a major source of microplastic exposure for humans. Here, we demonstrated microplastic contamination in marine food fishes from the upper Gulf of Thailand. Microplastics were found in gastrointestinal tracts of 46.9 % of fishes sampled, with a mean concentration of 1.6 ± 0.5 pieces per fish or 0.04 ± 0.01 pieces/g of fish tissue. Demersal fishes had higher contamination rates than pelagic fishes. Fibrous-type and blue-colored materials were the most abundant microplastics, while the most common polymers were polyester and polyethylene. No associations between microplastics and histopathological changes were detected. Estimated daily microplastic exposure for human marine fish consumers was 0.03 to 0.1 pieces per person. Although we expect a low risk of microplastic contamination in fish muscle because of very low calculated transfer rates, we recommend continuing surveillance, including evaluations of contamination in the food chain to ensure future seafood safety in this region.

2022). Most virgin microplastics are chemically inert and cause little direct chemical harm to fishes (Jovanović, 2017; Jovanovic et al., 2018), such as causing increased oxidative stresses in shrimp by polyethylene

fish than plastics or contaminants alone. These effects included alteration of liver gene expression and hepatic vacuolation. As a spillover effect, toxicity and accumulation of these contaminants in fish may be

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E-mail address: thanida.h@chula.ac.th (T. Haetrakul).

https://doi.org/10.1016/j.marpolbul.2023.115785
Received 24 June 2023; Received in revised form 27 September 2023; Accepted 11 November 2023
Available online 1 December 2023

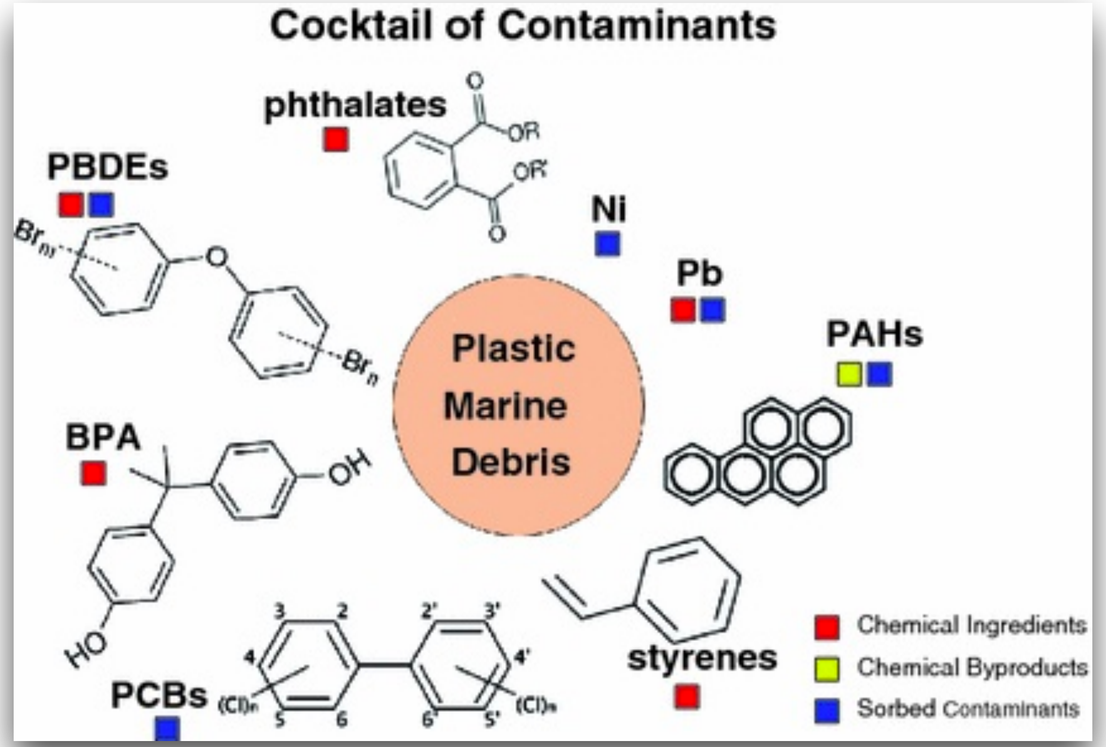
https://www.sciencedirect.com/science/article/pii/S0025326X23012201?via%3Dihub

Microplastics

- More than 80% of the world's ocean plastic pollution originates in Asia (Thevenon et al., 2014).
- In Thailand alone, plastic usage has increased by 7–8% annually (Apinanwattanakul, 2018), with individual consumption (on average eight bags per day) generating around 200 billion bags each year (Styllis, 2018).

Dangers of Micro-plastics

- Microplastics can contain / accumulate toxic contaminants (POPs)
- These chemical toxins can be transferred into food webs where they can cause reproductive abnormalities and affect behavioural effects in marine organisms
- All sea turtle species, 45% of all species of marine mammals, and 21% of all species of sea birds have been affected by marine debris
- Survey of North Pacific Gyre microplastic found: 50% contained PCBs, 40% contained pesticides, 80% contained PAHs
- *Persistent Organic Pollutants (POPs), Polychlorinated Biphenyls (PCBs), Polycyclic Aromatic Hydrocarbons (PAHs)*



Cocktail of contaminants associated with marine plastic debris. Contaminants associated with marine debris include chemical ingredients (*red squares*), byproducts of manufacturing (*yellow squares*) and those that accumulate from surrounding ocean water in the marine environment (*blue squares*)

https://link.springer.com/chapter/10.1007/978-3-319-16510-3_5

What can be done about this pollution?

1. Eutrophication
2. Mangrove conversion and destruction
3. Persistent Chemicals
4. Coastal Erosion
5. Marine Litter (Debris)

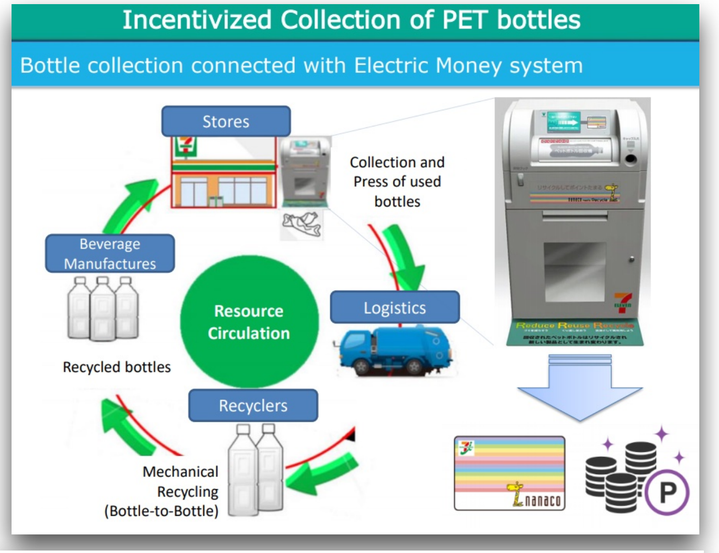
- The great majority of plastic litter, around 80%, come from land-based activities.
- Plastic debris makes its way to the ocean through rivers, drainage systems, storm runoff, industrial processes, beach visitors, ineffective waste management and illegal dumping.
- Underlying reasons are: (i) insufficient incentives to enact political change; (ii) scalar disconnects in waste management; and (iii) inadequate public and private sector ownership over plastic waste reduction.

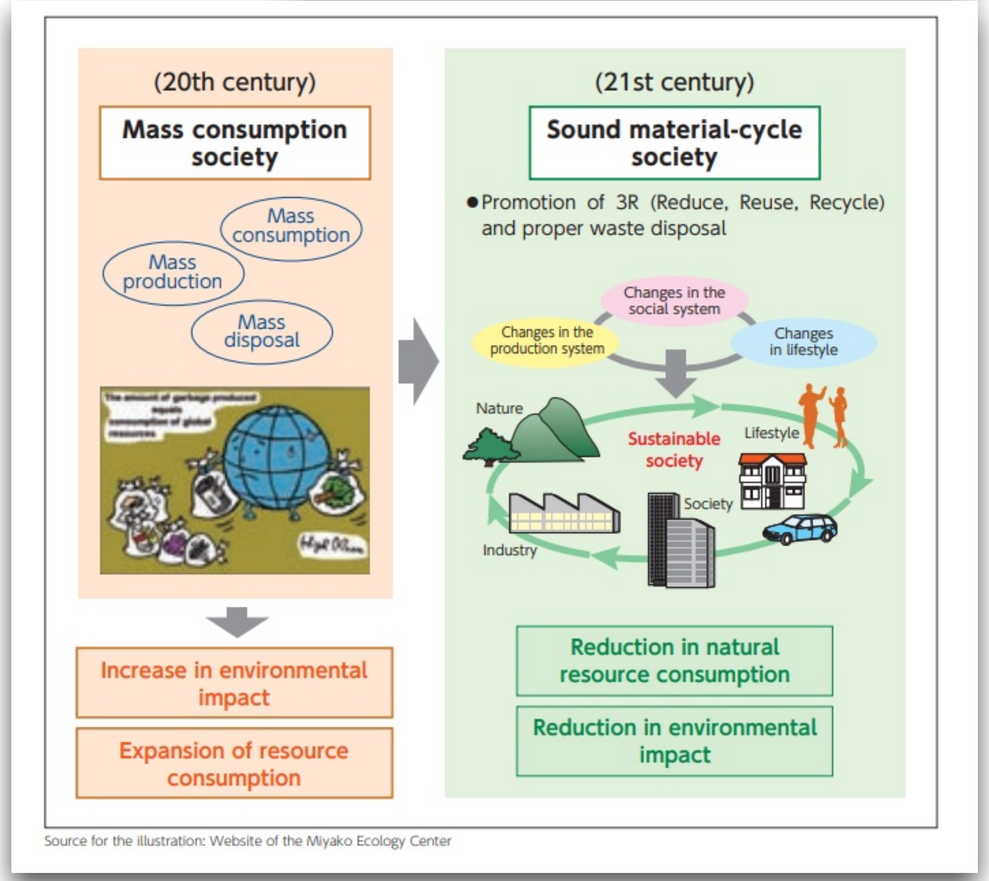
Can Thailand learn from Japan??

- Japan is also high-producing plastic country, but its successful waste management system has kept plastic discharge into marine environments relatively low. By contrast 80% of Thailand's marine plastic pollution is linked to land-based waste that is inefficiently managed

- There is currently no civic culture to support the sorting and cleaning of plastic waste. The head of the Thai Plastic Club lamented that 'if Thais were taught properly like the Germans and Japanese, they would separate and clean their waste

- Unlike Japan, the Thai government does not have a coordinating national-level waste management agency





Source for the illustration: Website of the Miyako Ecology Center