

*In the name of **GOD***

**Monitoring heavy metal  
contamination on the Iranian  
coasts of the Persian Gulf using  
biological indicators: risk  
assessment for the consumers**

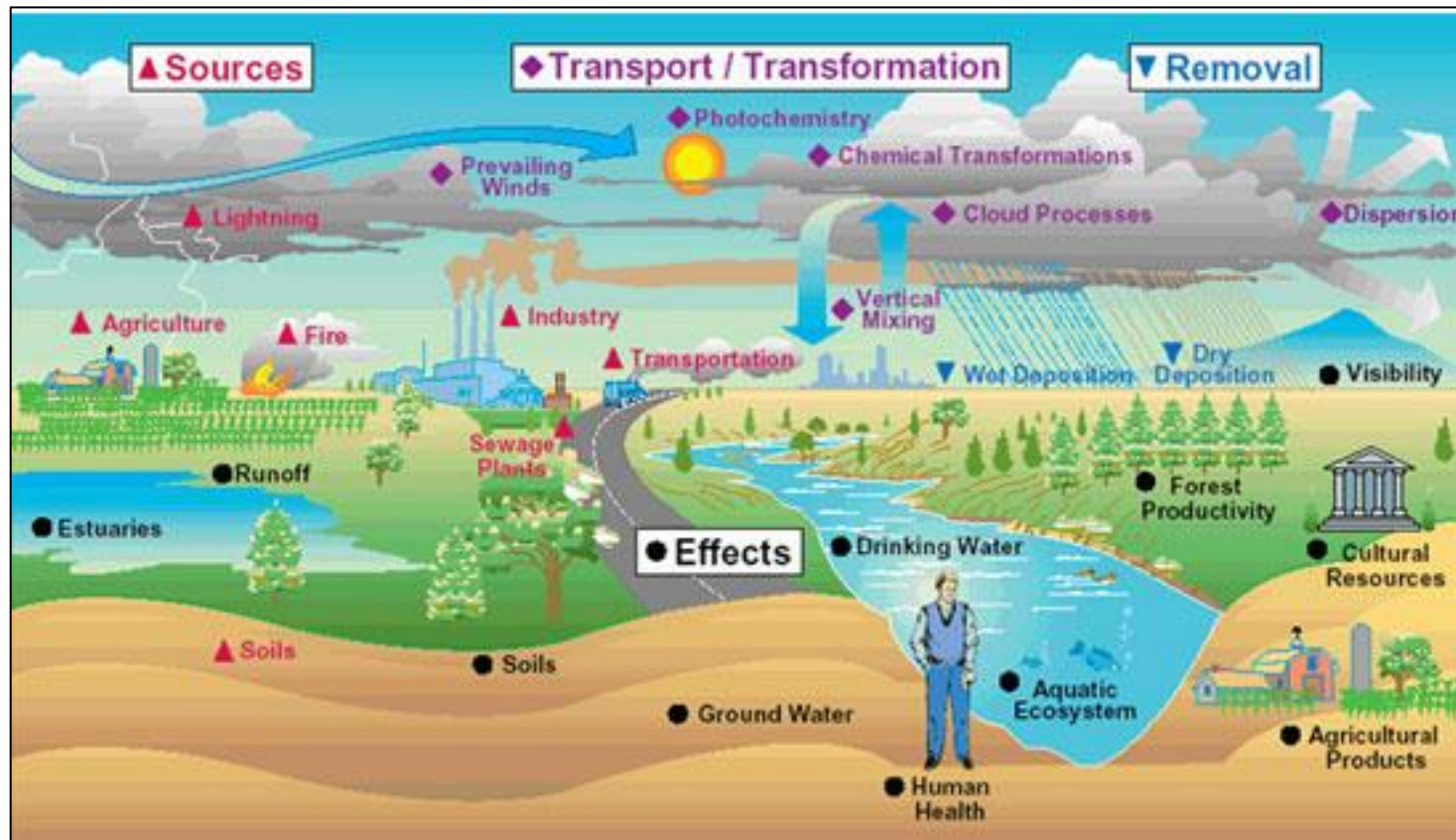


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# Heavy metals

- The study of aquatic habitats provides us with the knowledge of their biological and non-biological characteristics and a more comprehensive understanding of their ecological structure, which can help us with better conservation, as well as sustainable exploitation and management of such areas.
- Heavy metals are carried from natural and synthetic sources into the bodies and tissue of organisms and accumulate there, which increases their toxic danger and can cause severe problems for humans and aquatic ecosystems.
- Unlike other organic pollutants, metals are not destroyed or eliminated in the ecosystem but accumulate in sediments or living organisms and eventually enter the human body as part of a food chain.



(Caussy et al., 2003)

✓ It is important to know that Some heavy metals play an important role in the physiological, biochemical, and metabolic processes of living organisms and act as helpers for some enzymes, osmotic pressure regulators, but are toxic when overproduced.

## environmental protection

The goals of marine environmental protection, sustainability and increasing the efficiency of marine activities are a common factor. The main driver of any valid environmental management system (EMS) is to provide rules and enforce them. Over the past twenty years, the definition of environmental management has expanded from conservation to sustainability and cost reduction and risk.

## Potential impacts

development on the coastal ecosystem can arise from impacts on the morphological structure of the ecosystem, on the chemical components of the ecosystem and on the biological components of the ecosystem.

## water and sediment pollution

- ✓ Ports have a negative impact on water quality due to oil and bed contamination accidents. Shipping-related oil spills have had many negative effects on sediments and biodiversity of marine ecosystems. The phenomenon of eutrophication, which originates mostly from accidental leaks, causes large algal blooms that reduce water quality. Seagrasses and coral reefs are particularly susceptible to atrophy. Eutrophication is also very harmful to coastal ecosystems, leading to the destruction of the food chain and the loss of fish. In addition, dredging activities suspend sediments and increase water turbidity. Strong and practical laws must be enacted to reduce the negative environmental impacts associated with port development. Also, Sediment pollution can also be due to the deposition of pollution from river hills near the port.
- ✓ Repeated and periodic research on the extent of sediment pollution using biomarkers, the possibility of assessing related hazards and necessary and timely actions to reduce these hazards are essential.

NOx  
emissions  
(1000tonnes)  
from  
international  
shipping by  
sea region

Sea name	Emissions 2005	Emissions 2020	Emissions 2030	Emissions 2050
Baltic Sea	220	183	202	250
Bay of Biscay	474	425	488	633
Black Sea	47	36	44	54
Celtic Sea	22	18	20	23
Mediterranean Sea	1294	1116	1255	1587
North Sea	518	449	503	627
Rest of NE Atlantic	246	220	250	319
<b>TOTAL</b>	<b>2821</b>	<b>2447</b>	<b>2762</b>	<b>3493</b>

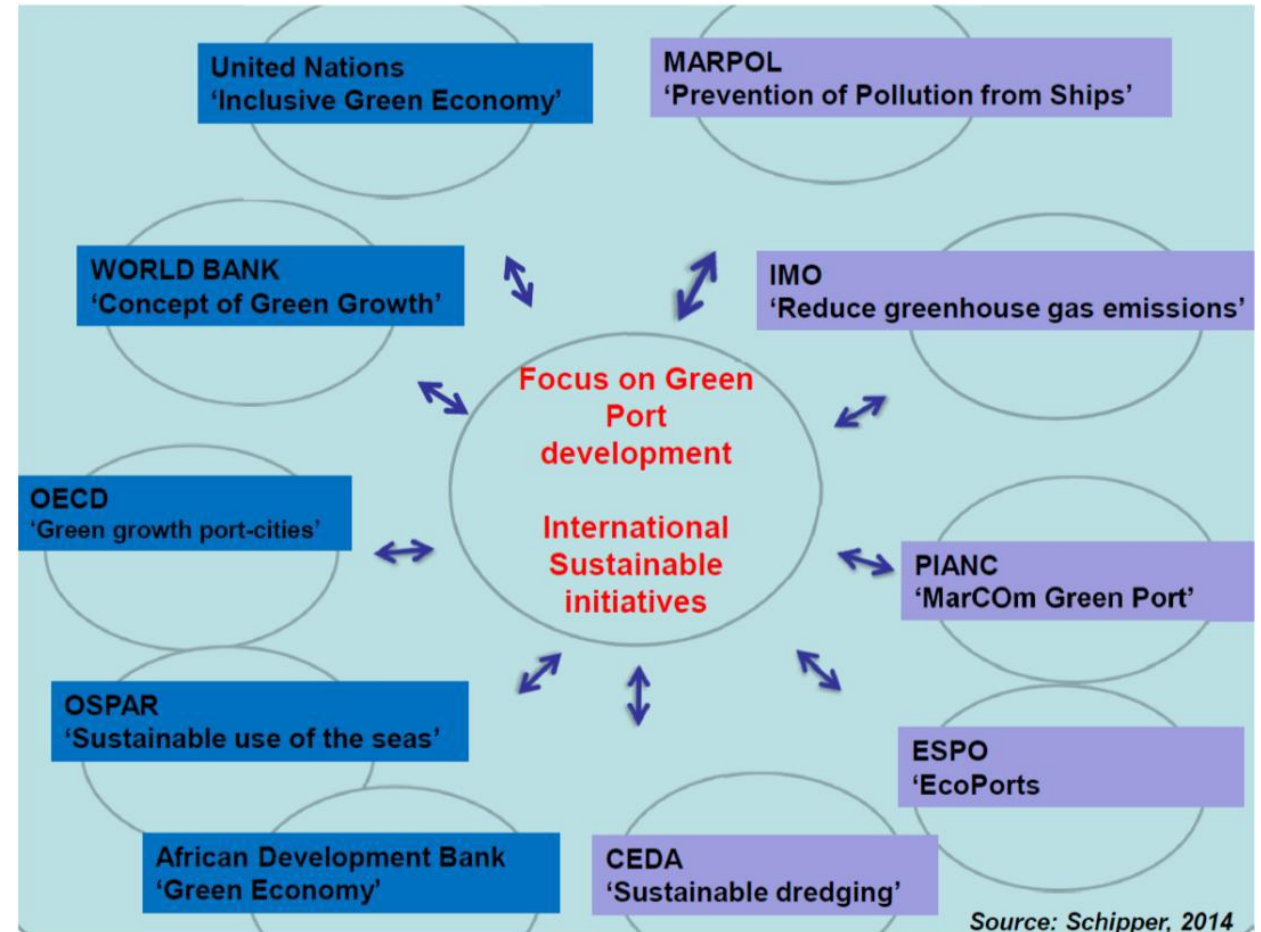
Source: Campling et al. (2013)

## Biology Impact

Changes in biology can be related to changes in species as well as the introduction of alien species. One of the most important factors for the entry of alien species is ballast water. In order to maintain stability, ships contain ballast water which they release after reaching their destination. It should be noted that alien species can cling to the hull and enter new environments. The International Maritime Organization(IMO) has strong and effective regulations on the uptake and discharge of living organisms into ballast water.



Several international maritime organizations and non-governmental organizations are focus on move away from the traditional approach and develop the Green Port concept. international organizations with a common engineering, environmental and socio-economic vision focus on its growth and development.



# TOP 10 ENVIRONMENTAL PRIORITIES 2018



17 October 2018

Source: European Sea Ports Organisation: ESPO Port Performance Dashboard

Table from the EcoPorts database shows the ranking of Monitoring Programmes:

<b>Monitoring programme</b>	<b>percent</b>
Energy consumption	67
Waste	65
Water consumption	61
Water quality	58
Noise	55
Air quality	53
Sediment quality	52
Carbon footprint	48
Soil quality	40
Terrestrial habitats	36
Marine Ecosystems	34

## ESI index

The Sustainable Environment Index (ESI) was first developed in 2002 by a team of experts in various fields at Yale University and the World Economic Forum (WEF). It was calculated and published in 2005 for 146 countries in the form of 21 sustainability indicators. The higher a country's score ESI means the better the environmental conditions in the future. These indicators are in the form of 5 groups.

1. Environmental systems
2. Reduce environmental pressures
3. Reducing human vulnerability to environmental pressures
4. Social and institutional capacity to take responsibility for environmental challenges
5. Global monitoring

## My research about Green Port for reduction of pollutions(2018)

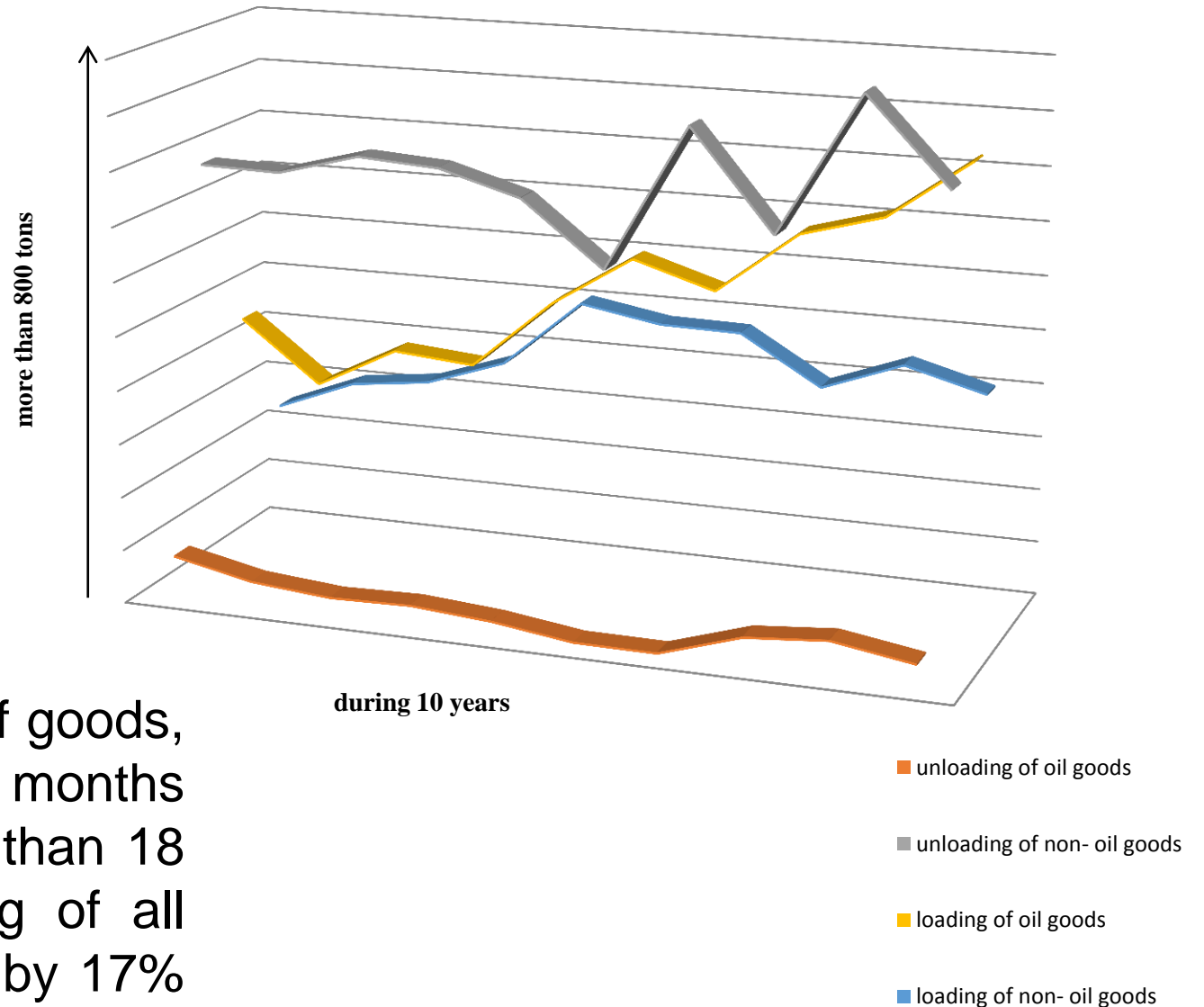
Production effluent	renewable energy	Port waste	Education	health	Water quality	Indicators
					1	Water quality
				1	r=0.786** P=0.007	health
			1	r=0.756* P=0.011	r=0.749* P=0.013	Education
		1	r=0.749* P=0.013			Port waste
	1			r=0.721* P=0.019		renewable energy
1		r=0.868** P=0.001	r=0.805** P=0.005			Production effluent

\*p<0.05

\*\* p<0.01

The purpose of this research was to identify the key indicators of sustainable development of ports using the combined exploration method. In this study, first by holding meetings with port experts involved in development projects and according to the indicators introduced by the United Nations, the initial indicators were obtained, based on which a questionnaire was prepared and distributed.

Loading and unloading of all types of goods, whether oil or non-oil, in the first five months of 2021 increased by 20% to more than 18 million tons. Unloading and loading of all types of basic cargo has increased by 17% compared to the same amount last year. (PMO, Aug 31, 2021)



## stability

Sustainable or green port development involves optimizing the economic, environmental and social benefits of ports. Port management and port users operate responsibly in a green port with high sustainability based on a green economic growth strategy. The port sector should hold regular and scheduled meetings with local, government and municipal institutions, conservationists, fisheries, tourism, and its activities should be coordinated with these relevant bodies in order to achieve and sustain green growth. Otherwise, multiple uses can have an irreversible effect on maritime ecosystems.

## *Siganus javus*

- ✓ family of Siganidae
- ✓ is a pelagic kind of fish
- ✓ lives in surface areas and around rocky areas and coral reefs
- ✓ has a vegetarian diet and omnivorous behavior
- ✓ lives in the waters of the Persian Gulf and the Oman Sea
- ✓ moves in small shoals
- ✓ feeding on seaweed
- ✓ most widely consumed fish in the region and is mostly sold in Southeast Asian and Arab markets





## *Padina algae*



- ✓ belong to the group of brown algae and are widely found in tropical and temperate coastal areas in intertidal and subtidal zones.
- ✓ About 6 species of Padina have been identified so far on the northern coasts of the Persian Gulf.

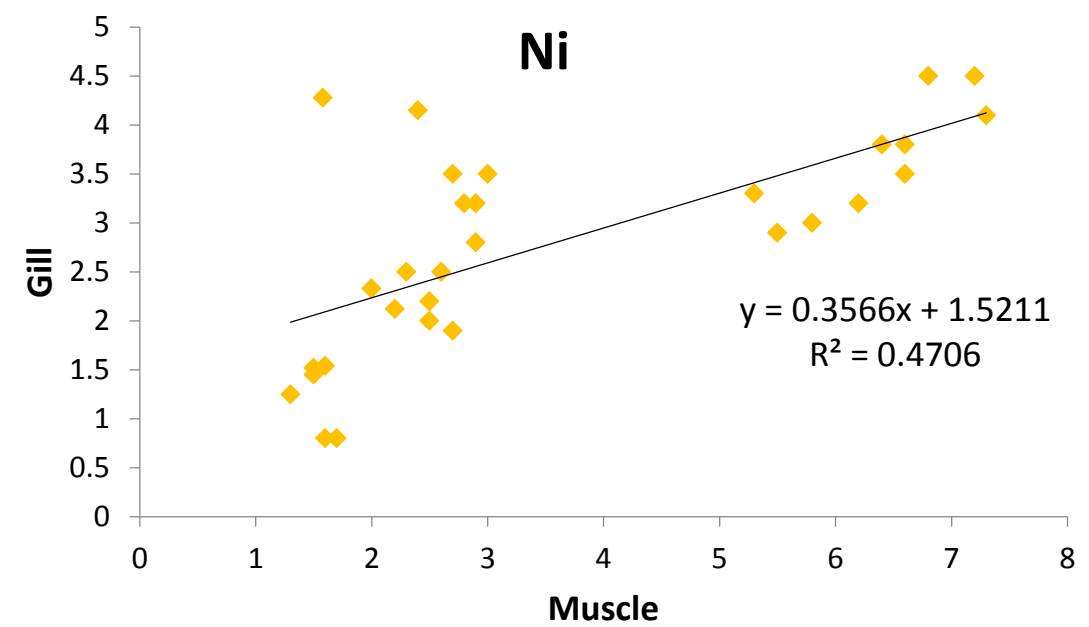
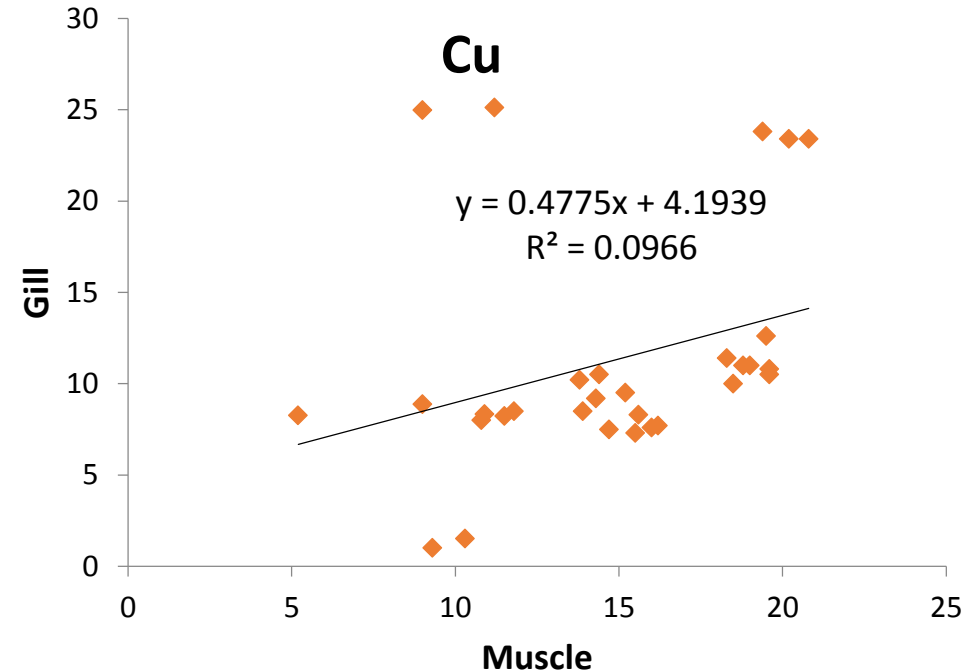
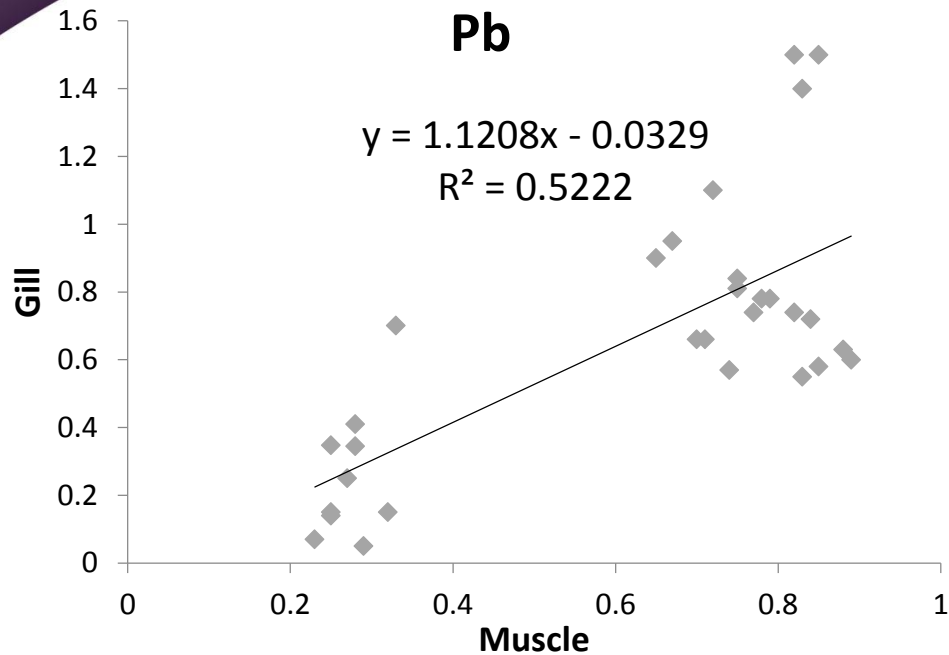
## *Sargassum algae*

are brown algae which grow mainly in the intertidal and subtidal zones as well as in shallow water areas and on rocky beds.



## The accumulation of pollutants

- **is not the same** in different types of tissue (muscle, gill, liver, etc).
- muscles are the most edible part of fish.
- it is important to measure the amount of heavy metal absorption in determining the general health status and in protecting the marine environment.
- use health risk assessment methods



# Risk assessment

- ❖ Formula and introduction valid reference
- ❖ result
- ❖ Methods and Solutions
- ❖ conclusion

## Calculating daily and weekly absorption

- Con in WW:  $1 - (\text{the amount of moisture in the fish's muscle}/100) \times \text{Con in DW}$ .

- Formula (1) 
$$EDI = \frac{C \times MS_D}{BW}$$

- Formula (2) 
$$EWI = \frac{C \times MS_W}{BW}$$

- <https://visual.ly/community/Infographics/health/weight-world>

## Cr(lim) and THQ= Target Hazard Quotients

- ✓ Calculating allowable fish consumption rate ( $CR_{lim}$ ) that is One of the most important methods of determining fish consumption limits is the method proposed by the US Environmental Protection Agency (EPA). In this method, based on the amount of metals in edible fish tissue and using a reference dose (RfD) according to a special Formula, the maximum acceptable amount of fish and fishery products to be consumed within a specific period can be calculated.
- ✓ THQ The potential hazard is the ratio of the concentration of an element to the maximum concentration of the element that does not cause problems in the body. That Formula presented by the EPA too, was used to calculate the probability of people being at risk of non-cancerous diseases. if the number is higher than one, it indicates a high risk of non-cancerous diseases.

## Amounts of intake for the 3 metals ( $\mu\text{g/g}$ wet weight) and average $\pm$ standard deviation and comparison of the amounts with international standards

According to these results, the amounts of heavy metals in the fish muscles were lower than the heavy metal consumption limits allowed by international standards. The calculated values of the risk of contracting non-cancerous diseases due to the consumption of all three metals were less than 1, indicating that eating *Siganus javus* had no adverse effect on consumers. Finally, the total hazard index (HI) in this study was below 1 (0.064).

Heavy metal	Average con	EDI	EDI	EWI	EWI	Cr <sub>im</sub>	Cr <sub>im</sub>
		Adults	Children	Adults	Children	Adults	Children
Pb	0.11 $\pm$ 0.06	0.05 $\pm$ 0.02	0.25 $\pm$ 0.13	0.36 $\pm$ 0.20	1.77 $\pm$ 0.97	2.23 $\pm$ 4.08	0.46 $\pm$ 0.84
Cu	2.79 $\pm$ 1.06	1.30 $\pm$ 0.49	6.28 $\pm$ 2.38	9.11 $\pm$ 3.46	43.98 $\pm$ 16.71	0.93 $\pm$ 2.44	0.20 $\pm$ 0.51
Ni	0.61 $\pm$ 0.37	0.28 $\pm$ 0.17	1.38 $\pm$ 0.83	2.01 $\pm$ 1.20	9.71 $\pm$ 5.81	2.30 $\pm$ 3.71	0.48 $\pm$ 0.78
Reference dose*		MTDI	PTWI	THQ			
Pb	0.0035 <sup>a</sup>	0.21 <sup>a</sup>	25	0.015			
Cu	0.037 <sup>a</sup>	30.00 <sup>c</sup>	3500	0.035			
Ni	0.02 <sup>a</sup>	0.30 <sup>b</sup>	35	0.014			
HI = 0.064							



# Common method for heavy metals removal in water

- **Physical**

- Adsorption
- Nanofiltration
- Ion exchange
- Ultrafiltration

- **Biological**

- **Chemical**

Bioremediation by Biosorbent



Bio-absorption (Biosorption)

## Bioremediation

is a newest technique used for heavy metal ions recovery from polluted environments. The technique utilizes innate biological (algae, bacteria, or plants) mechanisms that is sustainable. It is more appropriate technique when compared to the conventional chemical and physical techniques.

## Cons of other methods

- Costly and high on maintenance
- Produce many toxic sludge and chemical waste
- light efficiency removal of these methods when metal concentrations in solution are less than 100 mg/L.
- further required process

## Strategies of remediation

- Biosorption
- Bioaccumulation
- biomineralization
- biotransformation

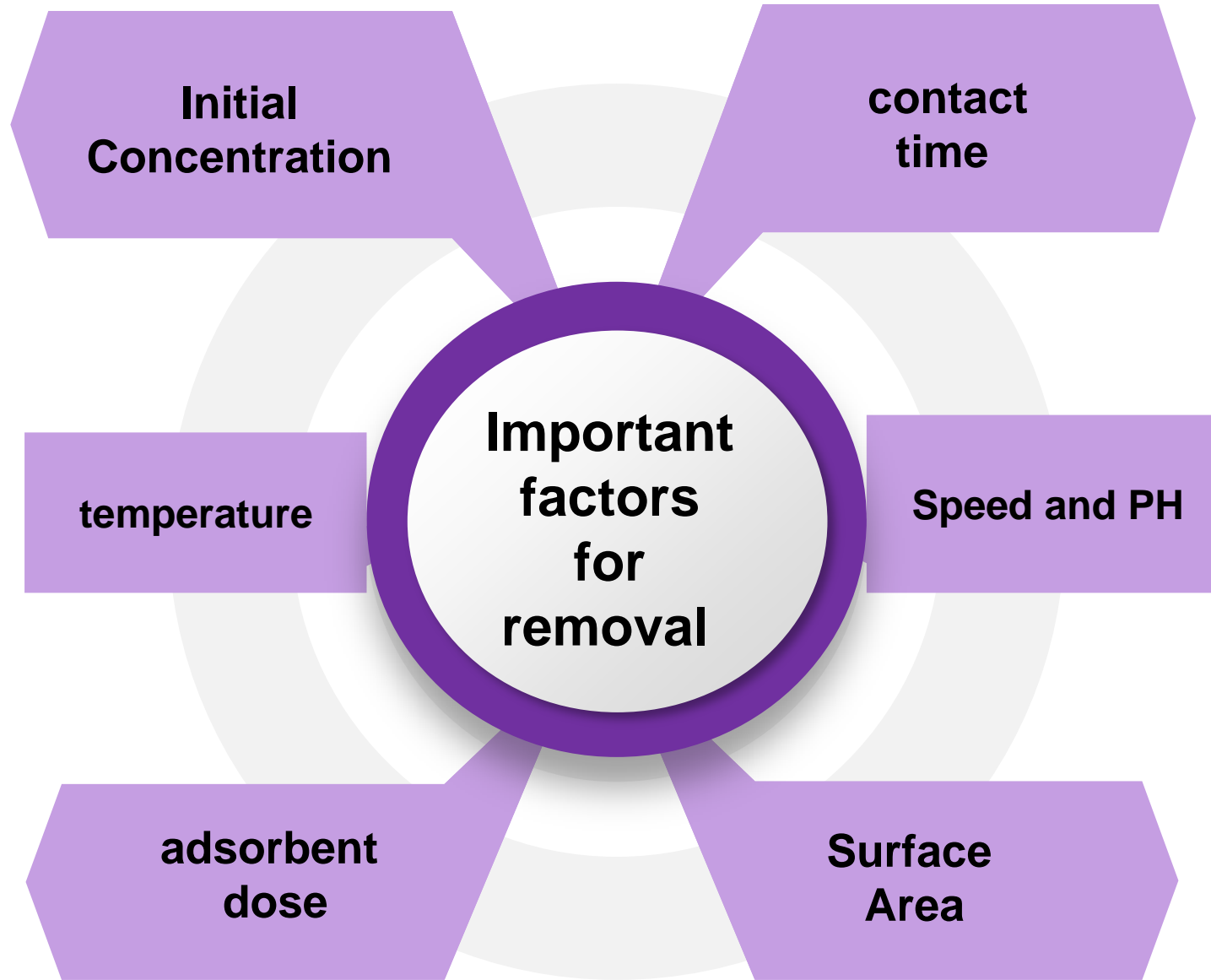
- Biosorption is a metabolically passive process....
- Bioaccumulation is an active metabolic process....

Totally

biosorption is preferable to bioaccumulation.

## Type of biosorbents

- ✓ Bacteria have been used as biosorbents due to their widespread presence and flexibility in a wide range of environmental conditions.
- ✓ Algae, especially brown algae, are known as good biosorbents due to their widespread presence in marine environments and freshwater with high absorption capacity.



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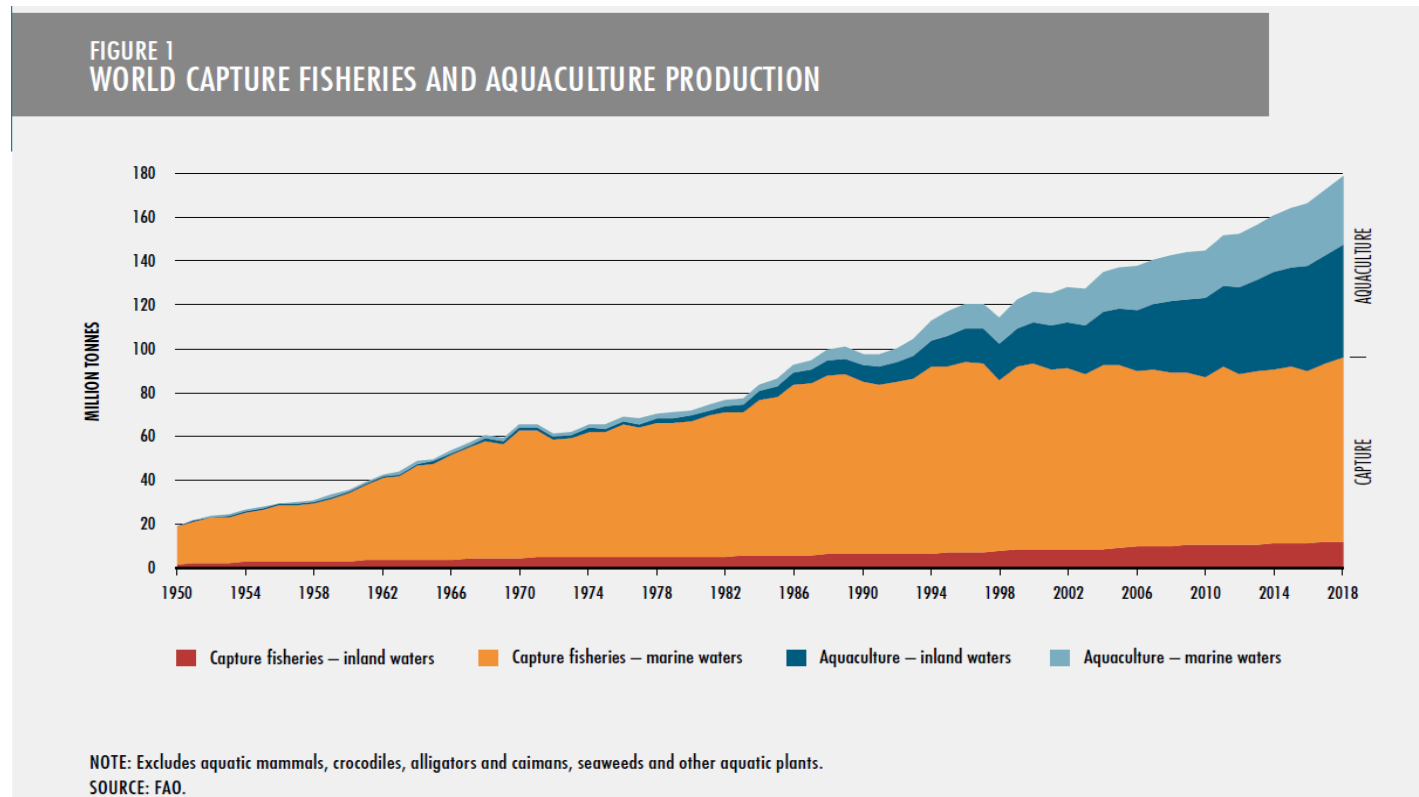


conclusion



# Increase in seafood consumption

- ✓ According to the FAO, about 179 million M/T of fish were produced in 2018 with a value of about USD 401 billion that total 156 M/T of this were used for human consumption. Of this amount, 84.4 million per tons were obtained of marine wild capture fisheries. And it is claimed that by 2030 this amount will increase to 204 million per tons, up 15 percent from 2018.



## Fish and sediments

- Fish are the best organisms for assessing the pollution of aquatic environments by toxic elements....
- Sediments actually serve as a reservoir for the accumulation of heavy metals in aquatic ecosystems and often store up to 99% of metals in them.
- FAO said that seafood plays central role in food security....

# Finally

- ✓ pregnant women and children should be careful
- ✓ children under 10 years are sensitive
- ✓ optimal consumption rate is varies
- ✓ industrialization and people's activities to expand their business

Due to the variety of diets, marine fish have a high level of metal accumulation in their tissues. The data also show that metal pollution is increasing in the study area. For this reason, in an effort to increase per capita fish consumption and change people's consumption behavior, special attention should be paid to the safety of seafood.

**With thanks for your attention**

**Good luck to you all...**



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