Panel: Innovation and Technology: Shipping and Energy Industries

Technologies for the assessment of climate change risks

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Significance and climatic vulnerabilities of the shipping and energy sectors

Sector socio-'economic significance: **Energy** the largest economic sector; **Shipping**, the facilitator of Trade and Development (80% of goods transported by sea (UNCTAD 2022)

Closely interlinked:

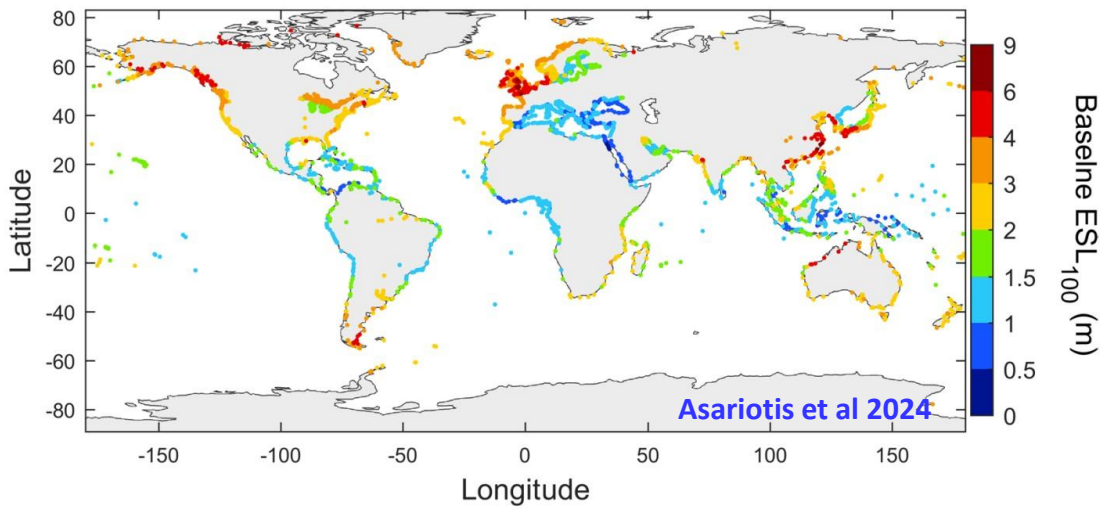
- **shipping** sector **needs energy** (fossil fuels?);
- and the **energy** sector **needs shipping** for (amongst others) energy (fossil fuel) transport

The two sectors **share** another characteristic: goods, passengers and energy must be loaded from and delivered to land: thus, their **critical network nodes** (seaports, oil/LNG terminals) are (mostly) **located** at the **coast**

But coasts are **vulnerable** to (amongst others) **mean** and **extreme sea levels** (ESLs) and **waves**

Global operational LNG terminals

Global (3630) ports: Baseline (1980-2014) ESLs 100



Shipping, Energy and Climate Change

Both sectors **linked to CC** (global warming & sea level rise- SLR) through their **contribution** to **GHG emissions**

Need to **assess/manage**:

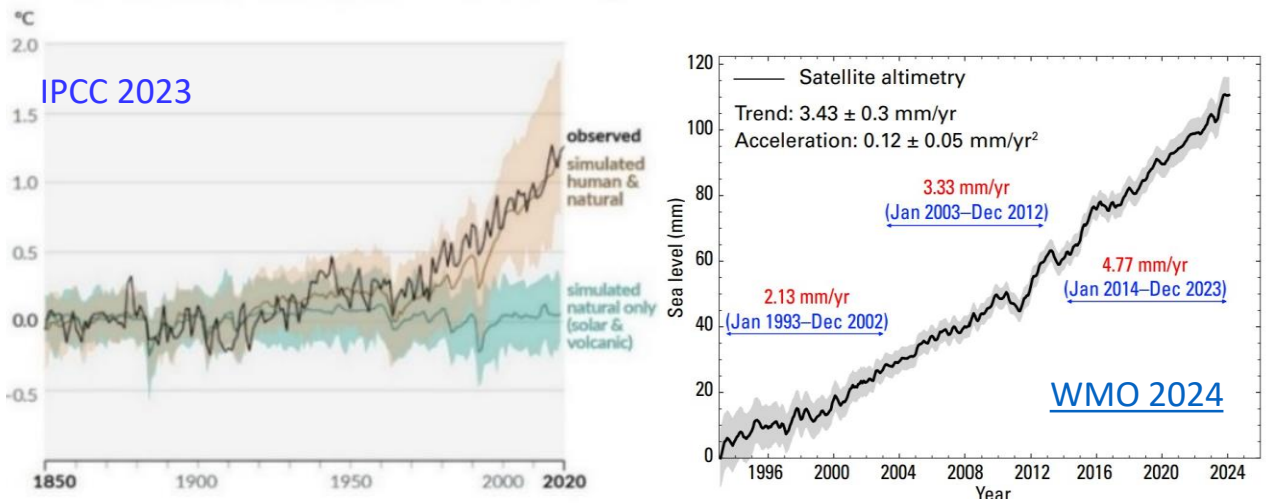
- the sectors' **impacts** on **Climate Change**;
- and **CC impacts** on these **sectors**

Present **unconditional NDCs cannot** achieve the goals of the Paris Agreement; **deep emission cuts** (28 % to 42 %) till 2030 required (UNEP 2023).

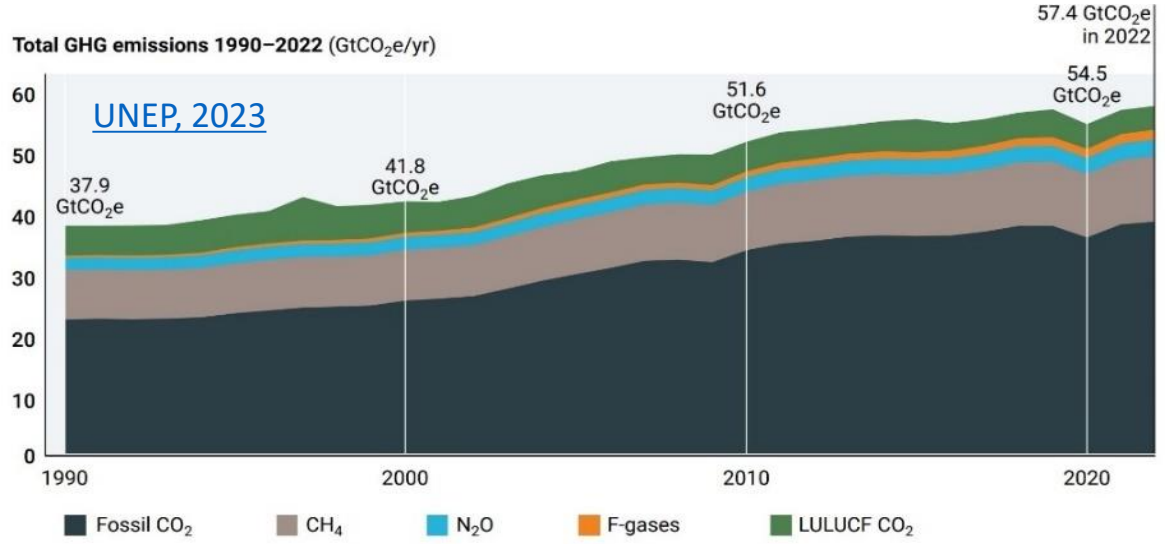
Decarbonization acceleration is **necessary** (tipping points);

CC impacts are, however, **unavoidable;** their assessment and management are **urgently needed**

As critical shipping and energy assets (seaports, oil/LNG terminals) are located at the coast, their **hazards, exposure** and **risks** should be assessed/managed



a) Observed and simulated temperatures driven by human/natural and natural forcing, b) mean sea level rise- SLR since the satellite record (1992)



Total net anthropogenic GHG emissions, 1990–2022

Risk assessment for ports and other coastal infrastructure

Risk assessment of seaports - and coastal energy assets is a **complex exercise**, but essential for effective risk management

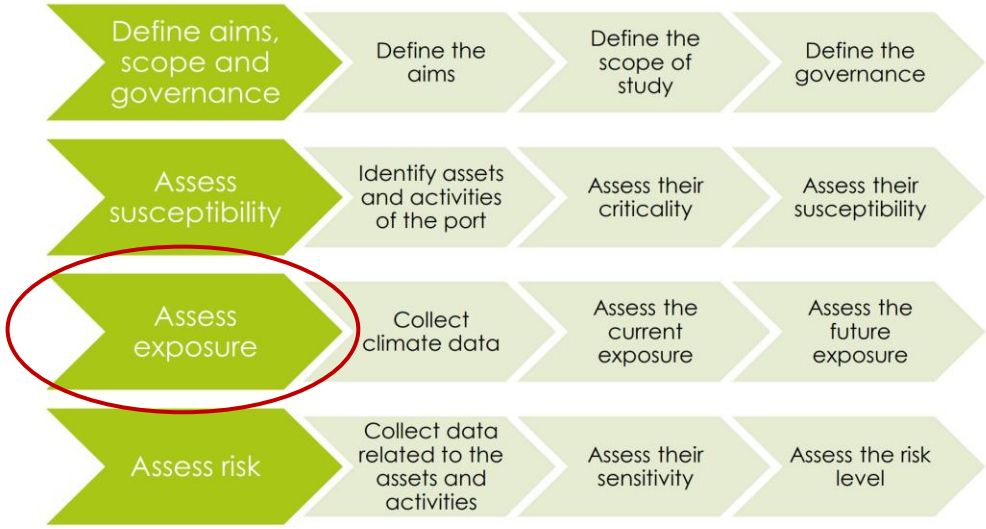
It requires clear definition of aims, and assessment of the **hazard** and asśet **exposure,** susceptibility and criticality

These are **not easy tasks**; seaports and coastal energy assets are **complex systems** with many **component interactions**

R&D in **technologies** needed to increase the **accuracy/consistency** of **approaches/tools** (e.g., earth observations - satellite, drones-monitoring sensors and hazard/exposure modelling to provide:

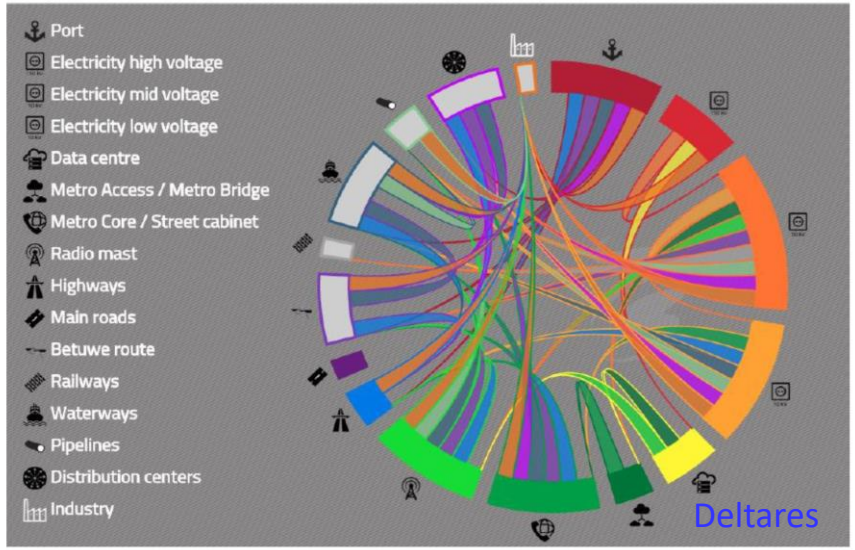
- Assessments of the **current and future exposure**; and
- early warning of **extreme events** and their impacts

Port risk assessment framework



INTERREG ECCLIPSE 2021

Rotterdam port interactions between port infrastructure, operations, services and utilities



Projections of extreme sea levels and waves at seaports and energy infrastructure

Mean **SLR,** and extreme sea levels - **ESLs** and **waves** will affect **ports** and coastal **energy infrastructure /operations**

Innovative 'soft technologies' needed to **assess future hazard** and **exposure -** numerical **model simulations**

The projections' **resolution/accuracy** depend on

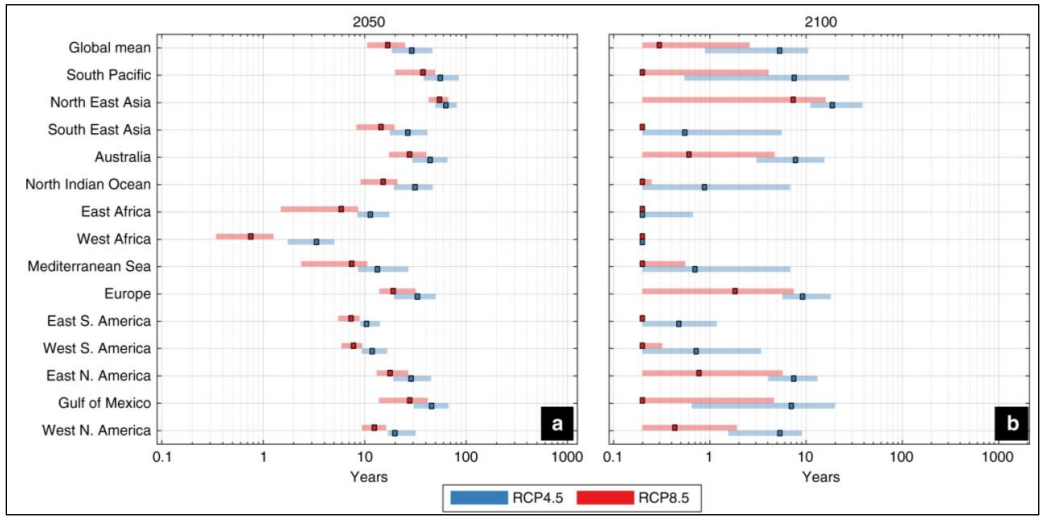
- the **scale** of application (global, regional and facility level); and
- the availability of high **quality** & **resolution data (**e.g. climatic and asset elevation data - earth observations) for assessing **hazards** and **asset exposure**

Percentages of global ports projected to face $ESLs_{100}$ of > 1 or 2 m above the present mean level under CC

Ports (no)	ESL_{100}	Percentages of ports		
		Baseline	RCP4.5, 2050	RCP8.5, 2050
All ports (3630)	> 1 m	92.5	96.8	98.1
	> 2 m	52.8	55.2	59.1
Large ports (160)	> 1 m	88.1	96.3	96.9
	> 2 m	50.0	53.1	56.9
Medium (362)	> 1 m	92.5	97.5	98.3
	> 2 m	51.1	53.6	57.7
Large/medium (522 total)	> 1 m	91.2	97.1	97.9
	> 2 m	50.8	53.4	57.5
Small (977)	> 1 m	93.4	97.1	98.5
	> 2 m	49.5	52.9	58.3
Very small (2125)	> 1 m	92.4	96.5	98.0
	> 2 m	54.9	56.6	59.9

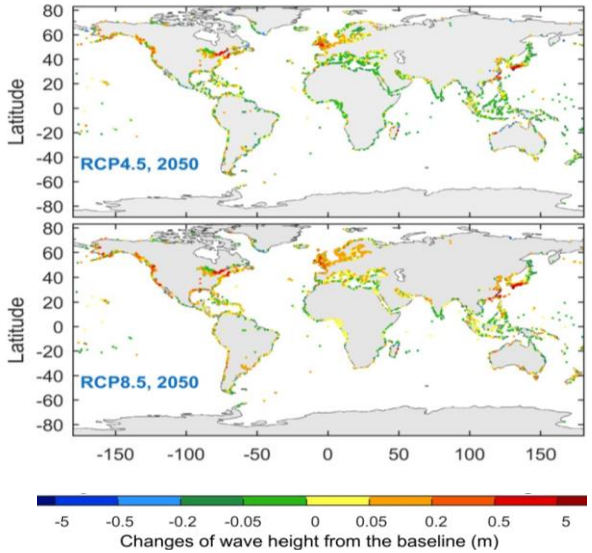
Asariotis et al 2024

Future frequency of the present coastal 1-100 year ESL in 2050, 2100 for the moderate and high emission scenario



Vousdoukas et al 2018

Model wave projections 2050



Asariotis et al 2024

Extreme event effects on transport infrastructure at facility level

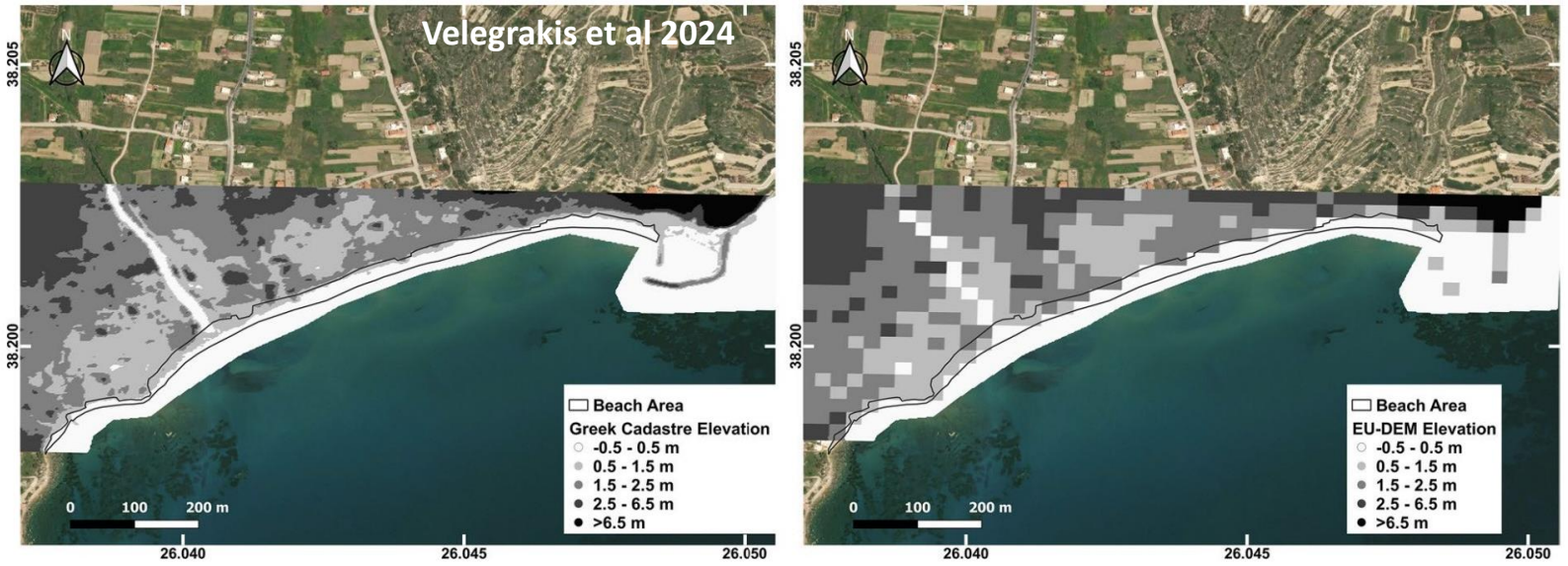
Projections at **facility level** are **costly** in time/resources and data sensitive, particularly on **elevation**

Innovations in earth observations (sensors, data & analysis) have **greatly improved** asset **exposure mapping**;

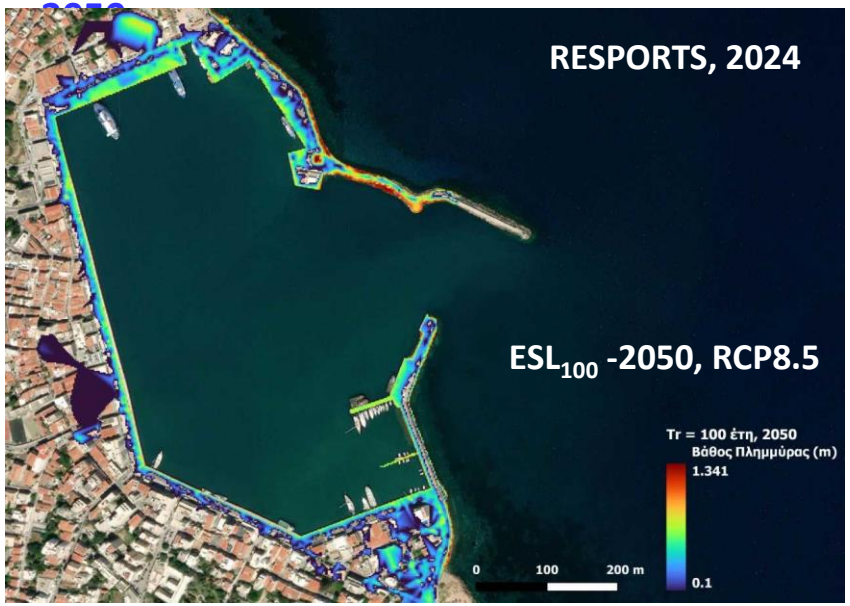
Improved assessments show severe flooding **impacts** on **ports,** particularly at **islands**

Further/massive improvements are **needed which require large human and financial resources**

Elevation map comparison: high resolution data (2x2 m) and standard European data (EU-DEM)



Chios, Greece max flood projected for



Concluding remarks

- Under the current/foreseeable GHG emissions, **large increases** in Climate Change **impacts** for **seaports and coastal energy assets** are projected from (among others) the (increasing) **mean and extreme sea levels** and **waves**

- **Impacts** and **adaptation needs** and **costs** will be **high**; they will also **vary** across regions and facilities

- **Projections** (particularly at **facility level) are data sensitive**, particularly asset **elevation**

- **Innovative approaches/tools** are being developed and **must be developed further** to **provide** more **accurate** and **consistent risk assessments** (globally, regionally and at the facility level)

Thank you for your attention!

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