ICCE 2018
36TH INTERNATIONAL CONFERENCE ON COASTAL ENGINEERING 2018
Baltimore, Maryland | July 30 – August 3, 2018
The State of the Art and Science of Coastal Engineering

MULTILEVEL METHODOLOGY TO ADDRESS CLIMATE CHANGE RISK IN PORTS

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OUTLINE

1. INTRODUCTION AND OBJECTIVE
2. MULTI-LEVEL METHODOLOGY
3. RISK ASSESSMENT
4. ADAPTATION
5. CONCLUSIONS

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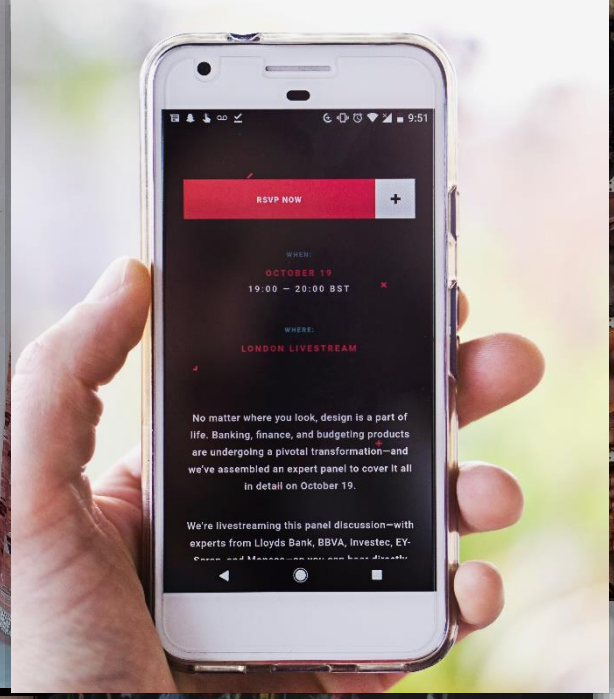

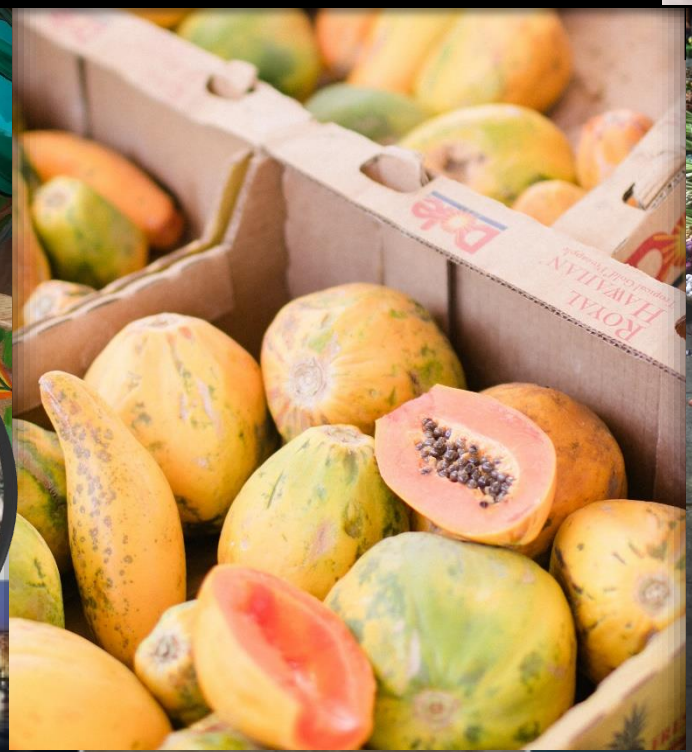

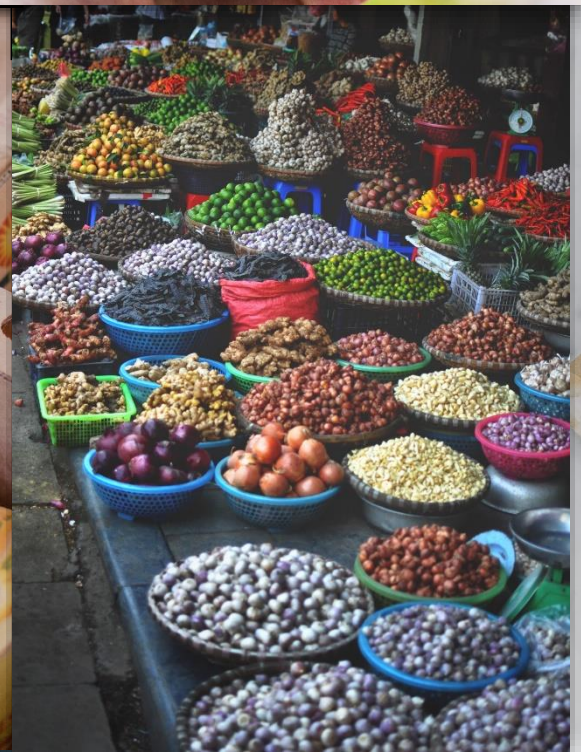


EARTH
DATA
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ECONOMY
BUSINESS
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TRADE
MARKET
INTERNATIONAL
INTERNET
MAP
SUCCESS
SHIPPING
TRANSPORTATION
LOGISTIC
CARGO
EXPORT
FINANCIAL
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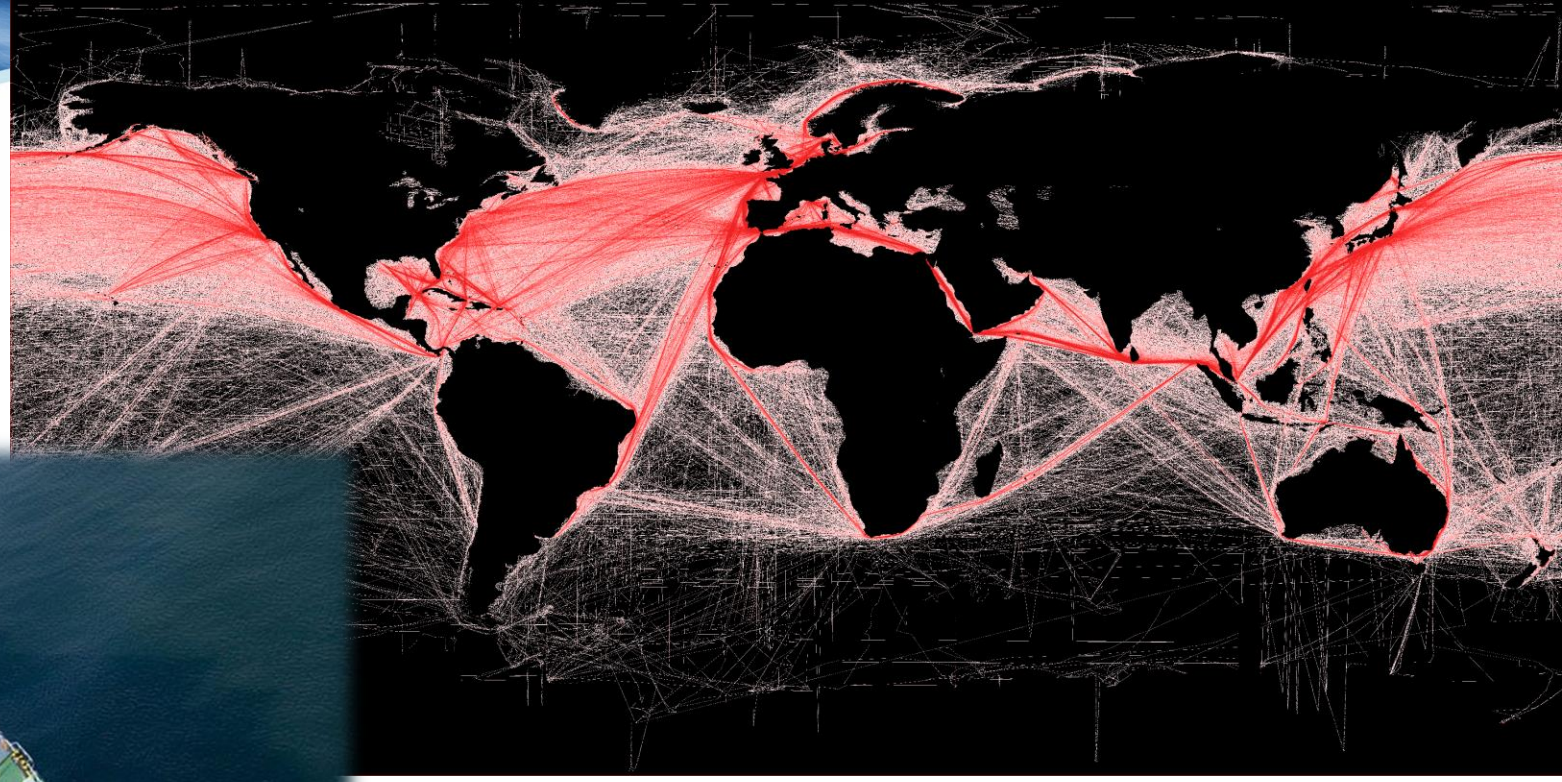


IMPORTANCE OF PORTS IN GLOBAL TRADE AND ECONOMY

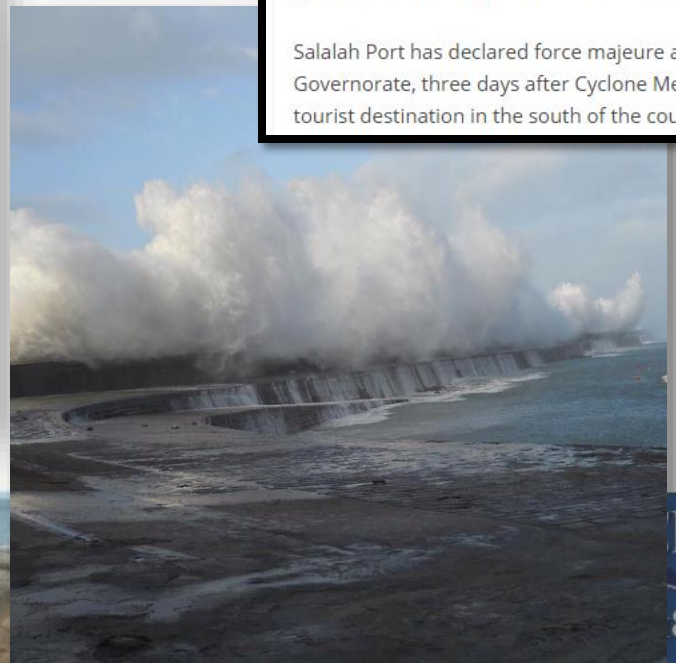


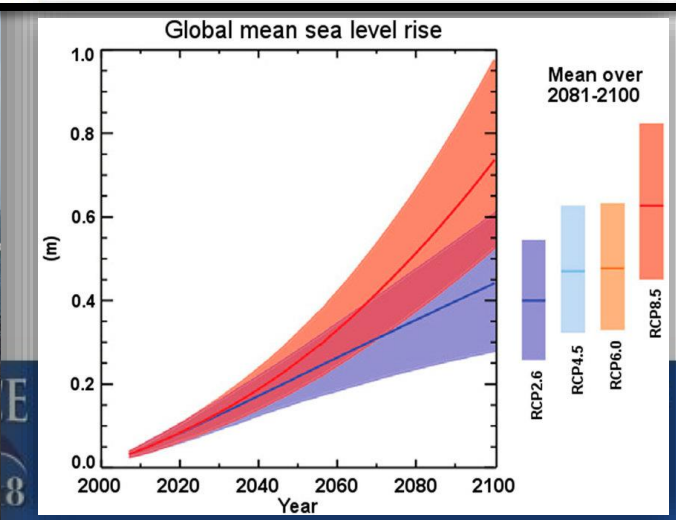

LONG-USEFUL LIFE, HIGH-EXPOSURE

Efforts to restore operations at Salalah Port move into high gear

28/05/2018 Conrad Prabhu Cyclone Mekunu, Salalah Port

Salalah Port has declared force majeure at its transshipment and logistics hub at Raysut in Dhofar Governorate, three days after Cyclone Mekunu unleashed havoc across large swathes of this popular summer tourist destination in the south of the country.





TO DEVELOP A **MULTI-LEVEL METHODOLOGY** FOR CONDUCTING CLIMATE AND DISASTER

RISK ASSESSMENT IN PORTS IN ORDER TO IDENTIFY HOT SPOTS AND PRIORITIZE

ADAPTATION STRATEGIES

IFC | International Finance Corporation
WORLD BANK GROUP

Creating Markets, Creating Opportunities

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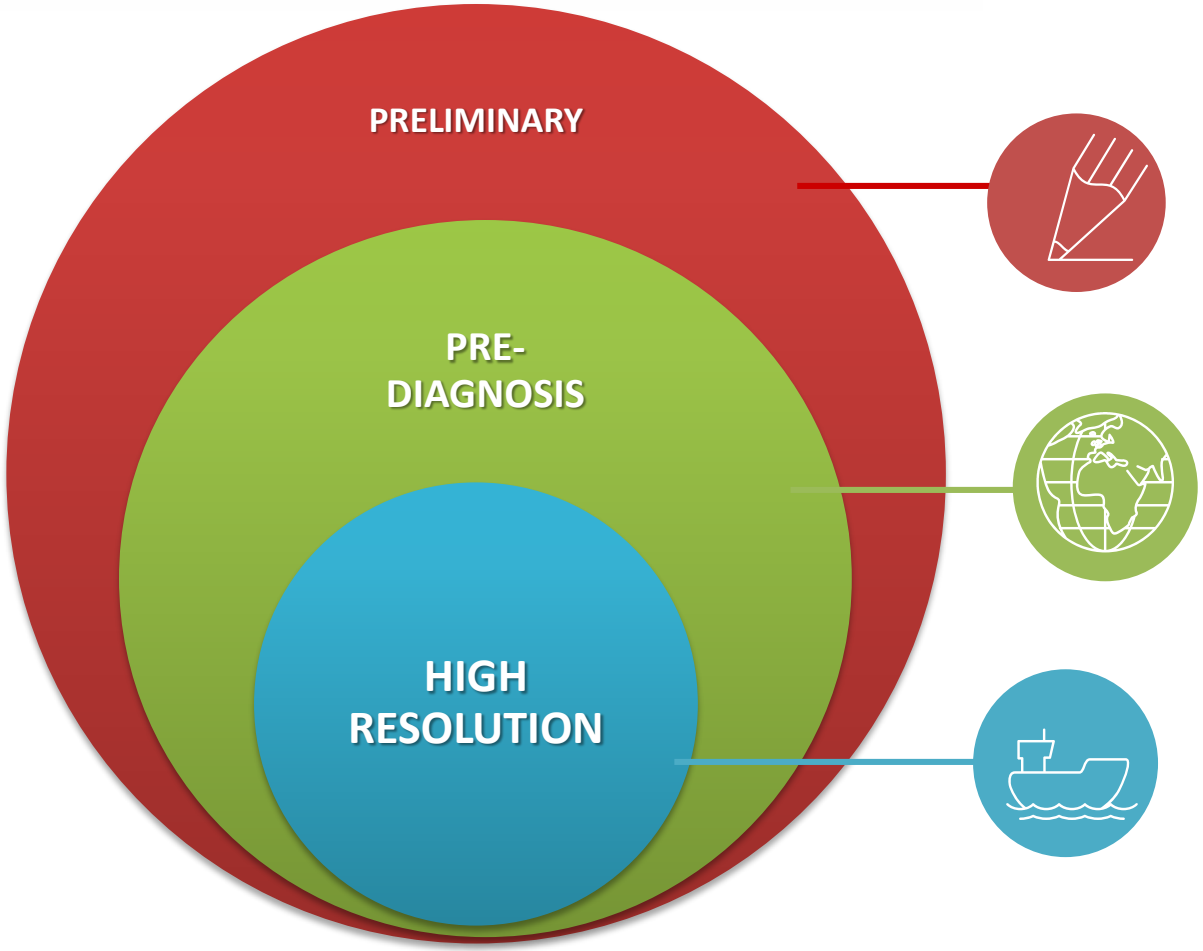
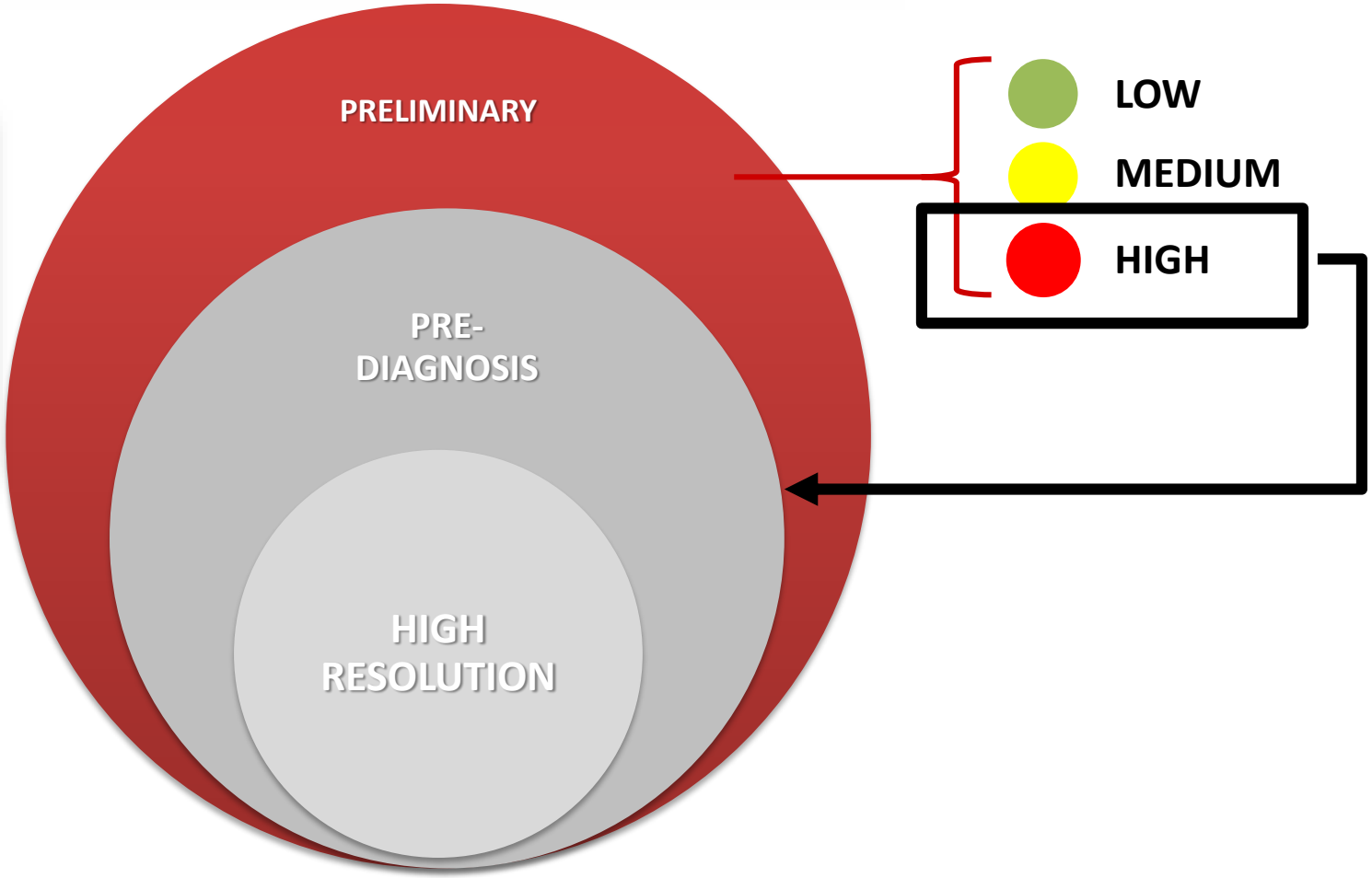
MULTI-LEVEL METHODOLOGY

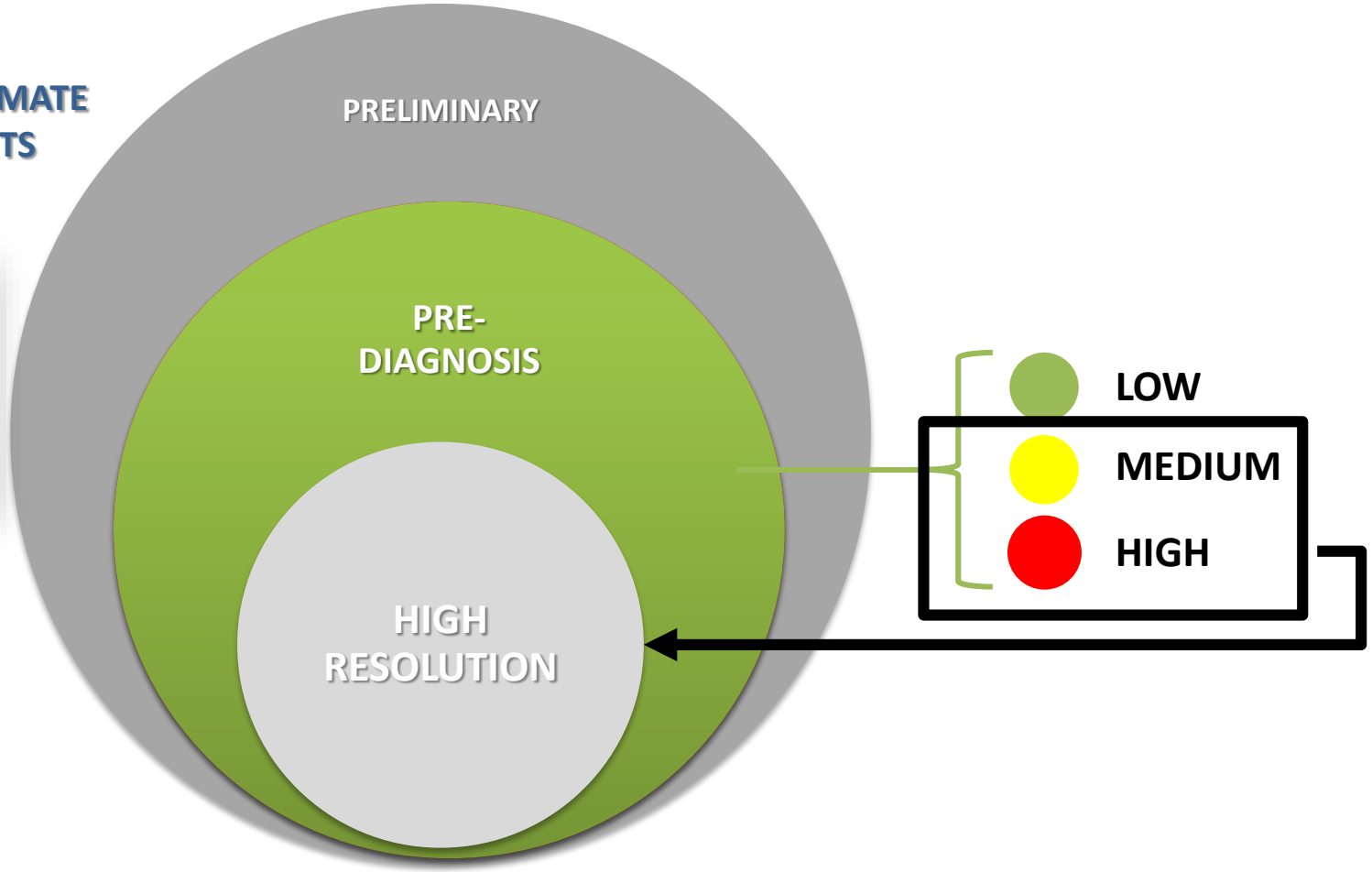


MULTI-LEVEL METHODOLOGY



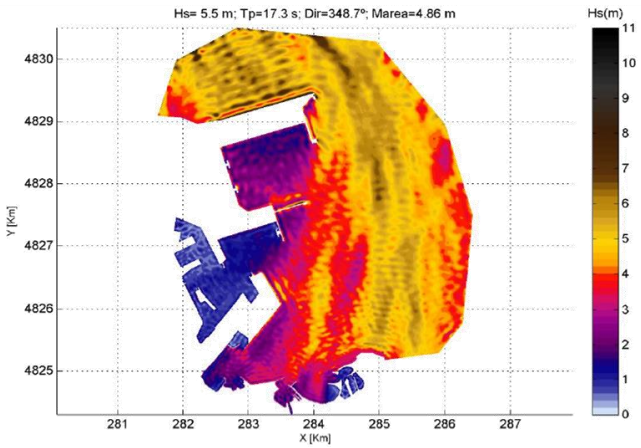
MULTI-LEVEL METHODOLOGY

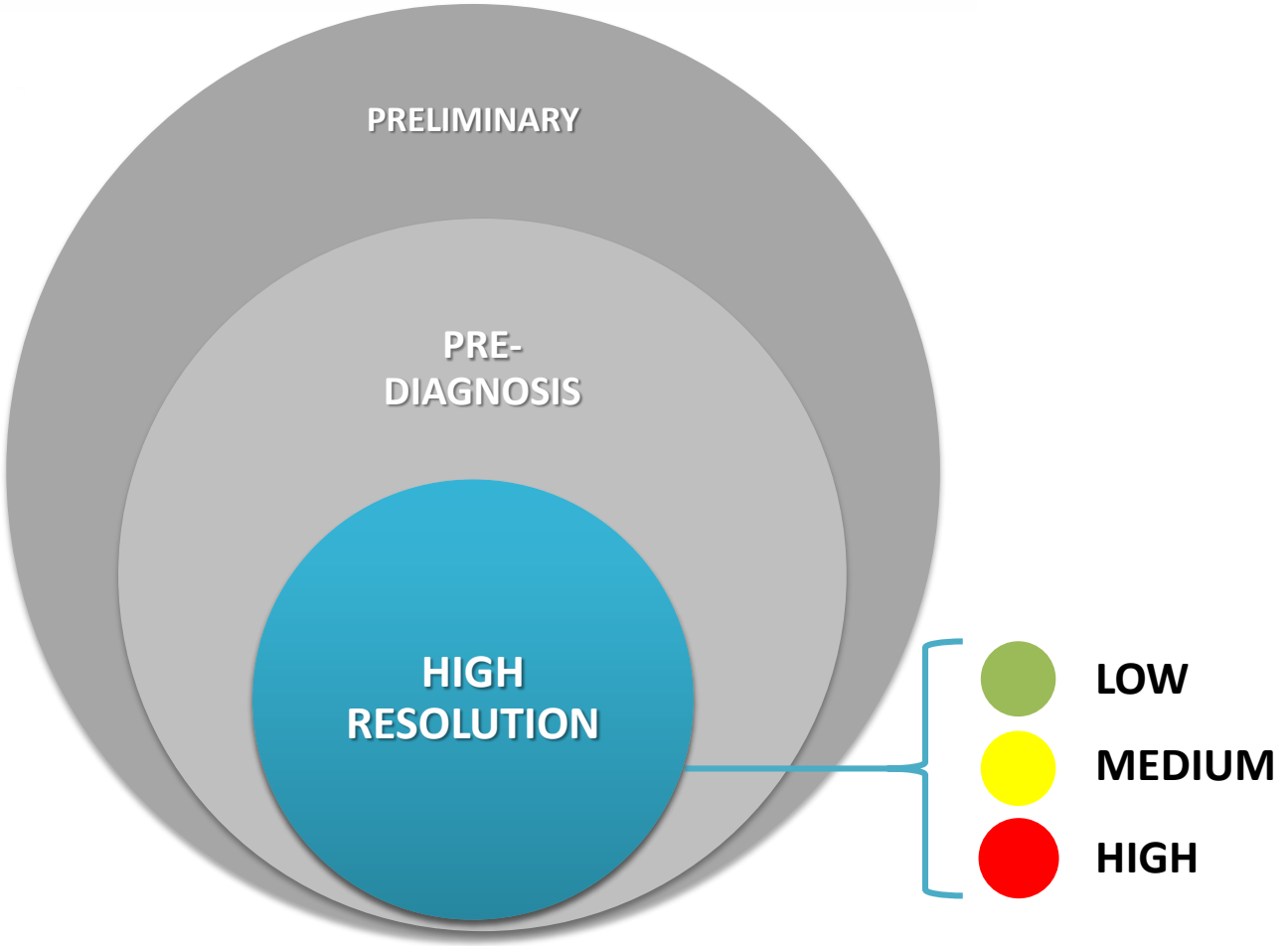
IFC International Finance Corporation WORLD BANK GROUP — SCREENING TOOL FOR CLIMATE RISK MANAGEMENT: PORTS AND WATER TRANSPORT






MULTI-LEVEL METHODOLOGY





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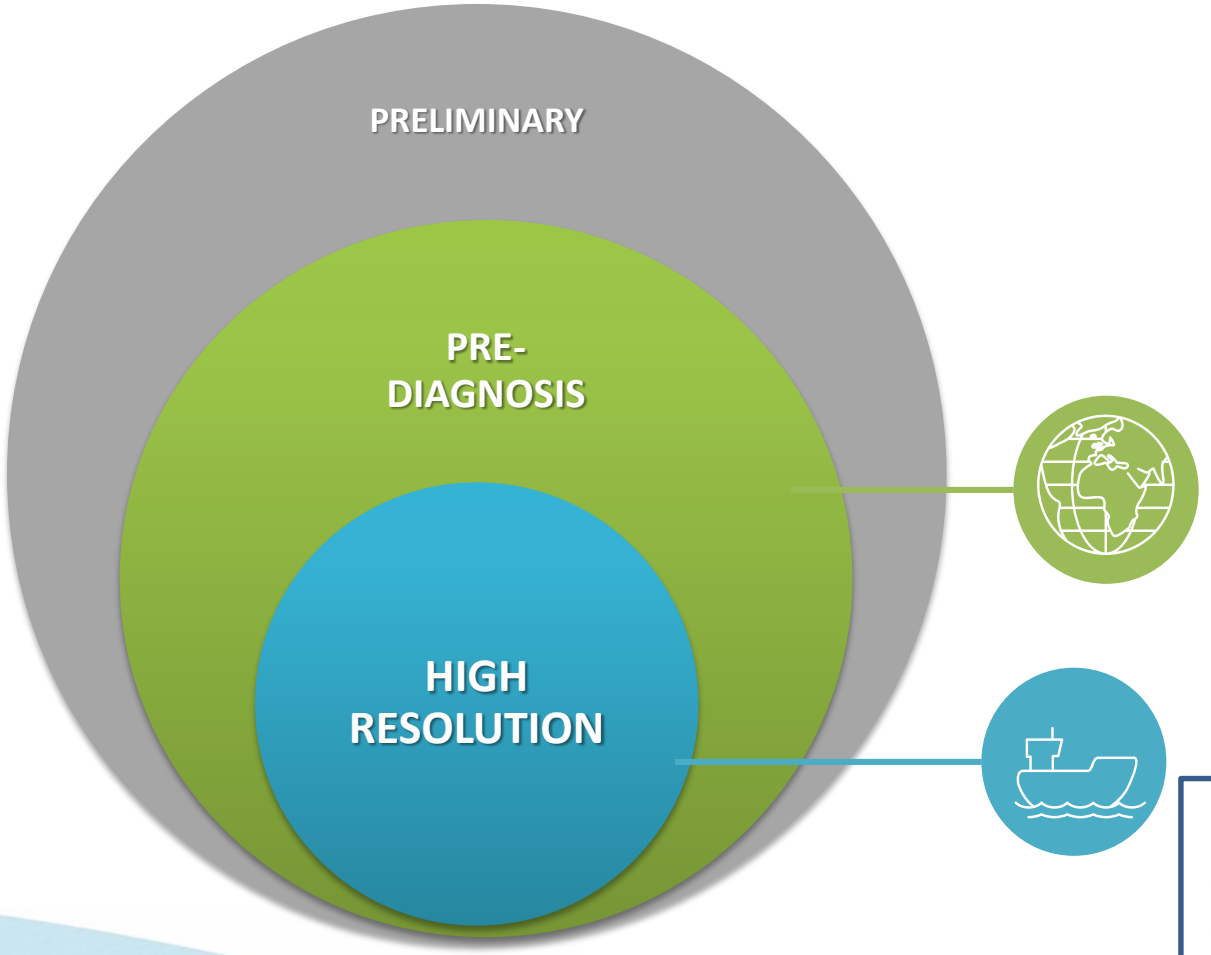
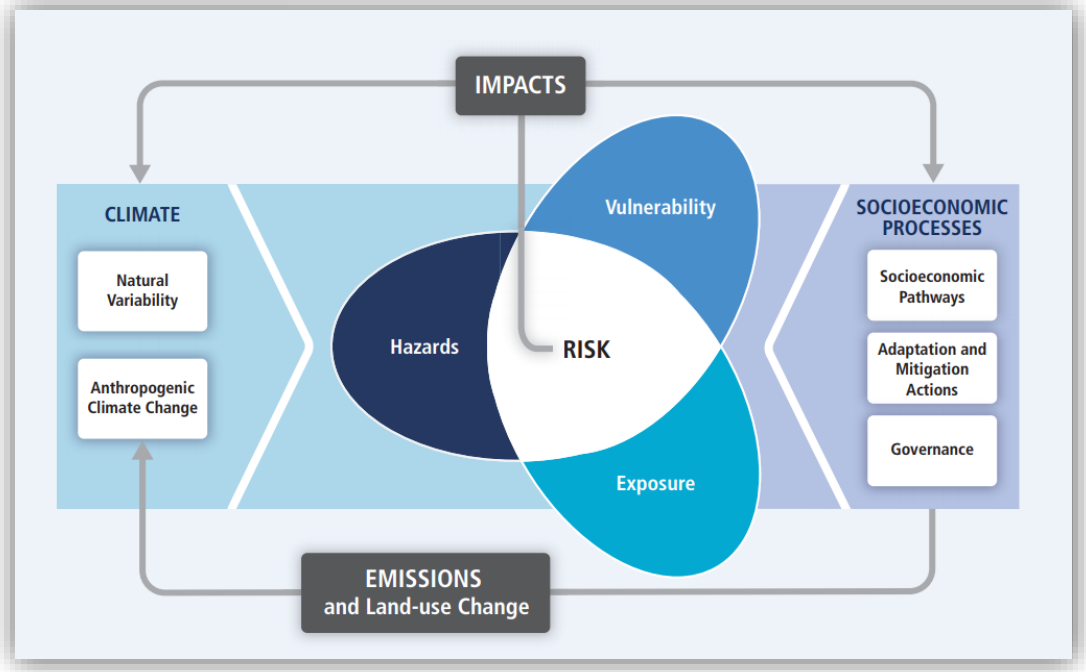
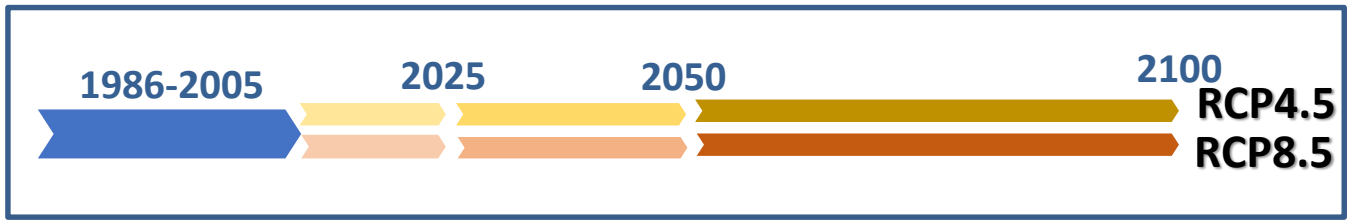
BASED ON GENERAL RISK FRAMEWORK ADOPTED BY IPCC (2014)



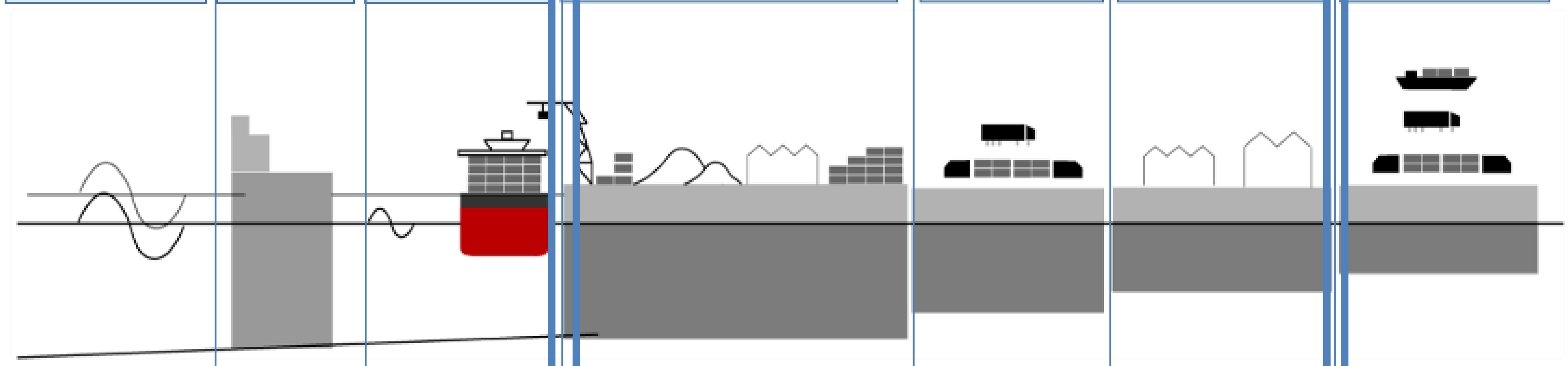


TERM HORIZONS AND CLIMATE SCENARIOS



IMPACT DEFINITION

	SEASIDE			PORT			LANDSIDE
	NAVIGATION ZONE	PROTECTION INFRASTRUCTURE	MANEUVER AREA AND BERTHING	LOAD/UNLOAD AREA	PORT EQUIPMENT	STORAGE	HINTERLAND CONNECTIONS



	NAVIGATION ZONE	PROTECTION INFRASTRUCTURE	MANEUVER AREA AND BERTHING	LOAD/UNLOAD AREA	PORT EQUIPMENT	STORAGE	HINTERLAND CONNECTIONS
IMPACTS	Agitation Water depth Wind patterns Visibility	Coastal flooding Overtopping Wave loads	Agitation Water depth Currents Wind patterns Visibility	Coastal flooding Overtopping Agitation Wind patterns Visibility Precipitation	Coastal and inland flooding Wind patterns Visibility Contamination Precipittion	Coastal and inland flooding Wind patterns Contamination Precipitation	Coastal and inland flooding Visibility Visibility Precipitation
CLIMATE DRIVERS	Mean Sea Level Astronomical Tide Storm Surge Waves Wind Fog Precipitation	Mean Sea Level Astronomical Tide Storm Surge Waves Wind	Mean Sea Level Astronomical Tide Storm Surge Waves Wind Fog Precipitation Temperature	Mean Sea Level Astronomical Tide Storm Surge Waves Wind Fog Precipitation Temperature	Mean Sea Level Astronomical Tide Storm Surge Waves Wind Fog Precipitation Temperature	Mean Sea Level Astronomical Tide Storm Surge Waves Wind Fog Precipitation Temperature	Mean Sea Level Astronomical Tide Storm Surge Waves Wind Fog Precipitation Temperature

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HAZARD: CLIMATE CHANGE AND EXTREME EVENTS

WAVES
STORM SURGE
TIDES
PRECIPITATION
WIND
AIR SURFACE TEMPERATURE
TROPICAL CYCLONES
…

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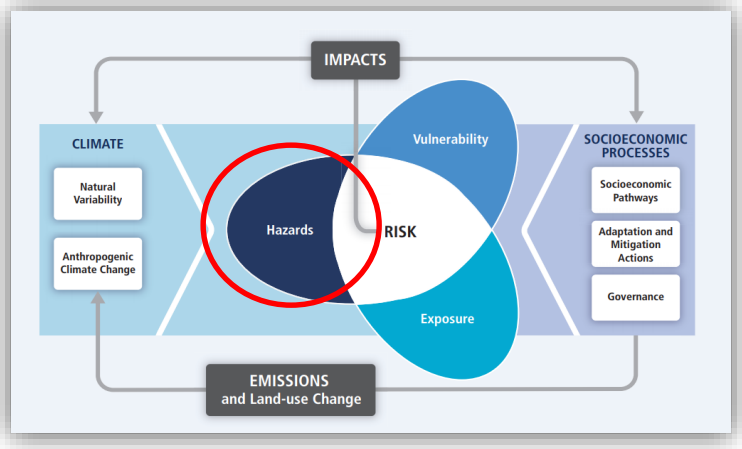
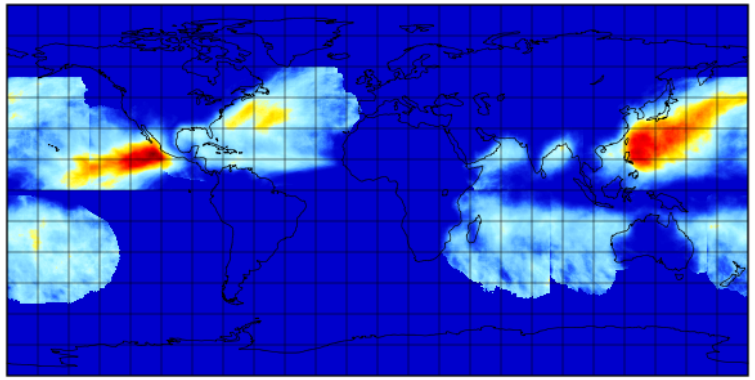
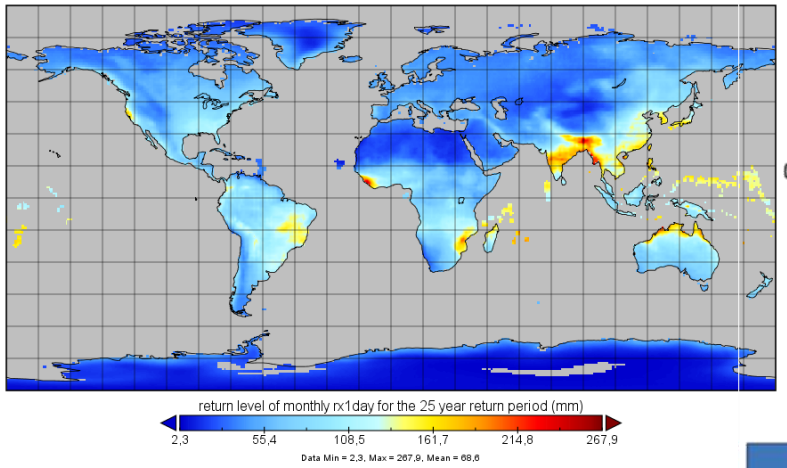


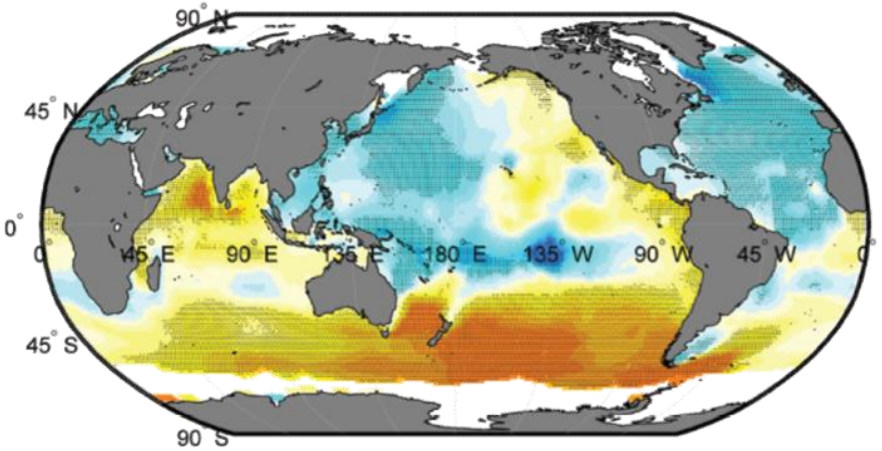
Camus et al. (2017). Earth´s Future

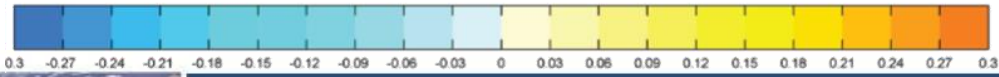
return period of annual tcwind for the 79 kt return level



return level of monthly rx1day for the 25 year return period







TERMINAL DEFINITION

OPERATIONS

- Approaching maneuver
- Stay in anchorage
- Loading/unloading cargo
- Transfer/storage apron area
- ...

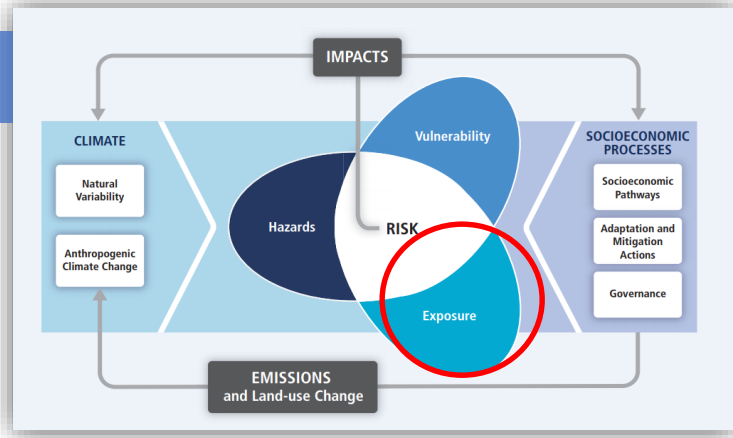
ASSETS

SHARED

- Coastal breakwater
- Navigation channel
- Drainage system
- Rail
- Roads
- ...

TERMINAL´S OWN ASSETS

- Berths
- Pavement
- Dolphins
- Cranes
- Tugboats
- Warehouse
- ...



EXPOSURE

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IFC Climate Risk Mana
water transport Scree

Step 2 - Local characteristics (t

Sector
The user will have to choose between two se
inland waterways transport"

Region
It is mandatory for the user to choose the co
This action allows the Screening Tool to uplo
market indicators to the pecularities of each
enter the economic values when requested.
consult the user manual.

Step 2 - Location and terminals

Local Characteristics | Terminal

TERMINAL — READ MODE

NEW — NEXT STEP

Question 1	Terminal type?	Container - Standard
Question 2	Cargo sensitive to rain?	Yes
Question 3	New terminal?	Yes
Question 4	Is the terminal vulnerable to overtopping?	Yes
Question 5	Total initial investment (write "X" if unknown)?	M USD
Question 6	Annual cargo volume?	TEU
Question 7	Revenue per cargo unit (write "X" if unknown)?	
Question 8	Max capacity	
Question 9	Annual grow	

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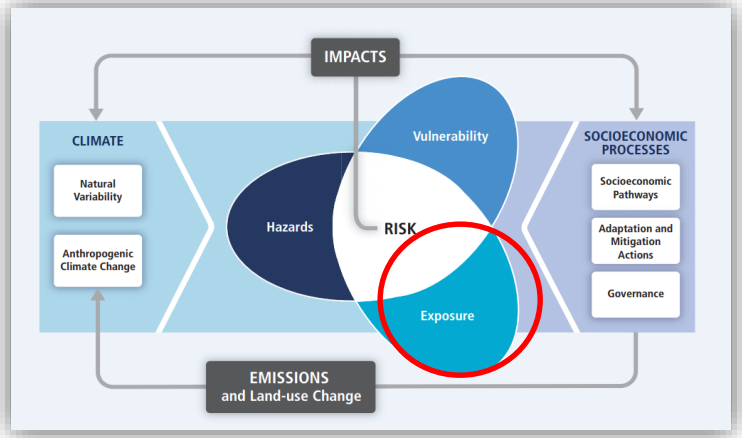

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IFC Climate Risk Manag
water transport Screeni

Step 3 - Main assets sensitive to c

The objective of this window is to gather the mai
characteristics that are part of the terminal selec
that are affected by climate change.

The window is divided into two tabs -In the first o
assets that are shared by more than one termina
shared by two terminals, with a 50% allocation fo
the user will enter those assets that belong only
procedure for both parts is the same: the user w
button, select the asset and answer several que
necessary information to analyze the impacts of
case of shared assets, it is mandatory for the user to indicate the percentage of allocation that belongs to the selected terminal and in case of non-shared assets the user will have to specify the number of exactly equal elements.

To see a example picture, please use the keyboard to choose the asset - not the mouse.

As in previous steps, all questions are mandatory.

Once all the data is entered, please proceed to STEP 4

STEP0 | STEP1 | STEP2 | STEP3 | STEP4 - T1 | PROCESS | Default Values

Step 3 - Main assets sensitive to climate change

Shared assets | Terminal assets

Assets of the terminal 1 Container - Standard — EDIT MODE

SAVE — CANCEL

Type of asset	breakwater-vertical
% of allocation	
Question 1	
Question 2	
Question 3	

breakwater-rubble
breakwater-vertical
channel-delta
canal-inland water
port basin
port railway
port road
water drainage system

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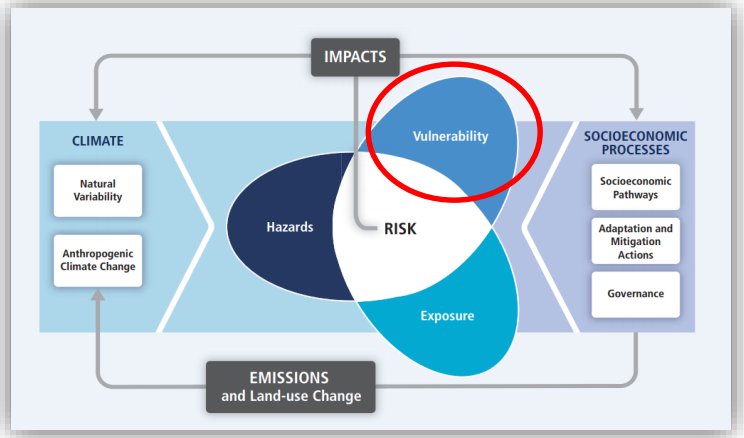
VULNERABILITY

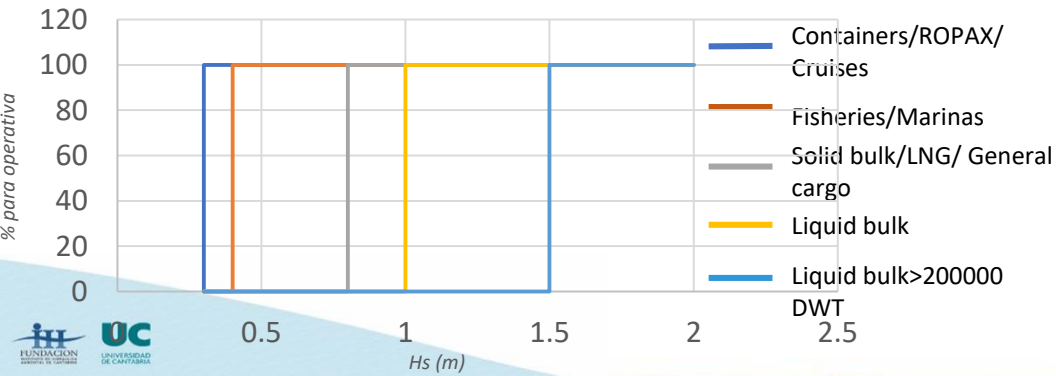
OPERATIONS

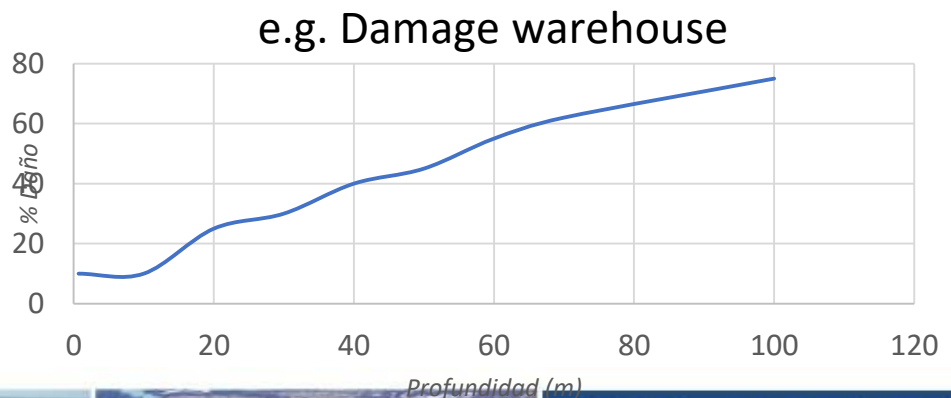
Operability functions

ASSETS

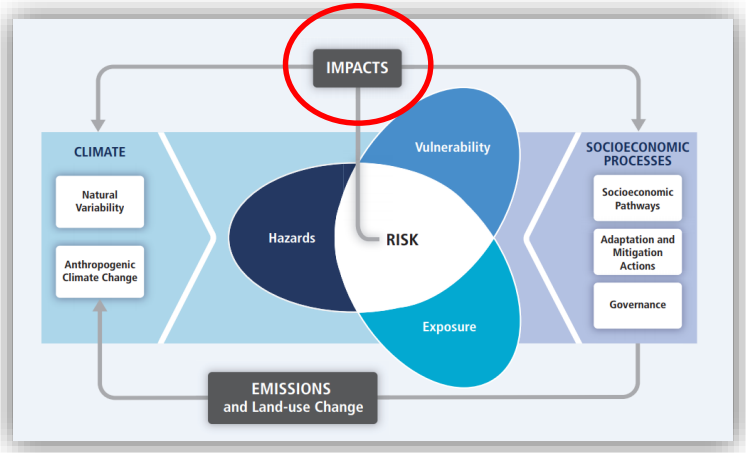
Damage functions

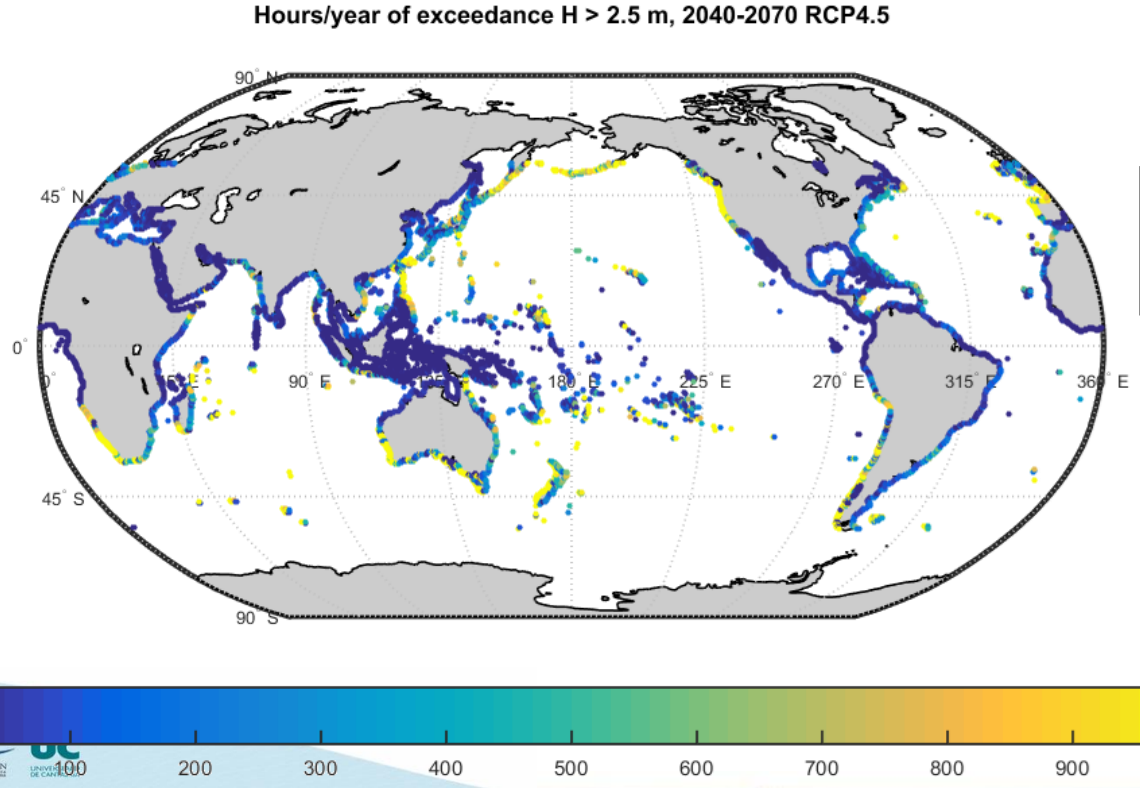




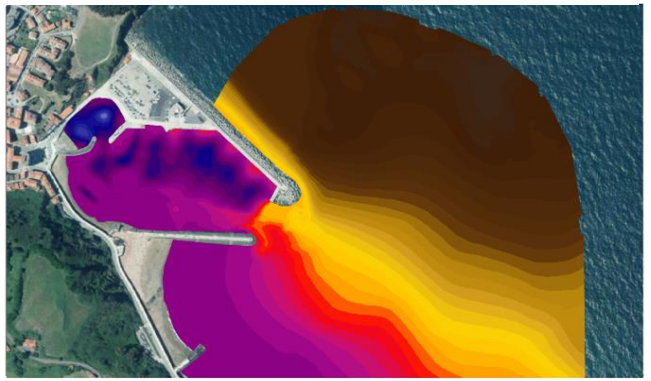


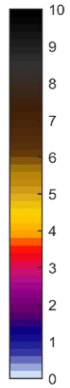
AGITATION. E.g. # hours/year exceeding Hs>30 cm
OVERTOPPING. E.g. # hours/year exceeding q=0.1 l/m/s
COASTAL FLOODING. E.g. # hours/year exceeding 10 cm of flooding depth
WIND. E.g. # hours/year exceeding 20 m/s

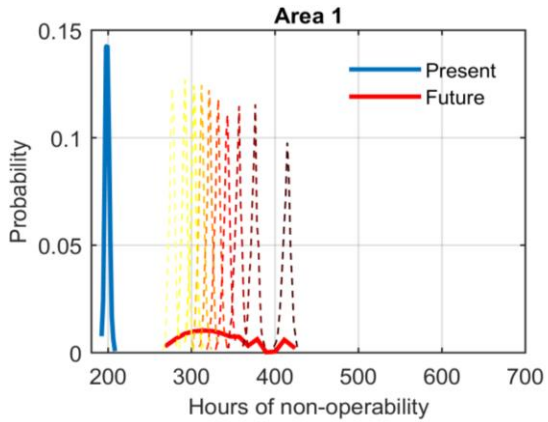




Paula Camus. Probabilistic Assessment of port operability under climate change







FINANCIAL

MONETARY LOSSES
INVESTMENT INCREASE

+

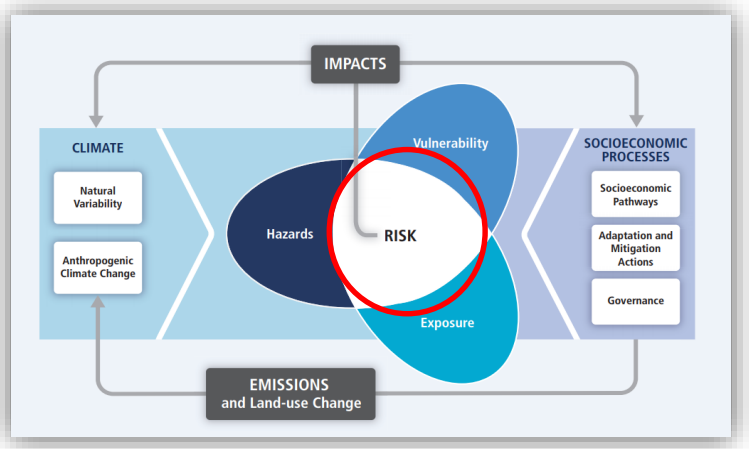
ENVIRONMENTAL

BIODIVERSITY
ECOSYSTEMS
…

+

SOCIAL

POVERTY
CASUALTIES
…



ADDITIONAL INVESTMENT		
	High Risk	Risk ≥ 5%
	Medium Risk	2% < Risk < 5%
	Low Risk	Risk ≤ 2%

High Risk	High Risk	High Risk
Medium Risk	Medium Risk	High Risk
Low Risk	Medium Risk	High Risk
Risk ≤ 2%	2% < Risk < 5%	Risk≥ 5%
Low Risk	Medium Risk	High Risk
MONETARY LOSSES		

CONTAINER TERMINAL IN PORT OF MANZANILLO, MEXICO

CONSEQUENCES DUE TO CLIMATE CHANGE

(baseline year USD, not discounted)

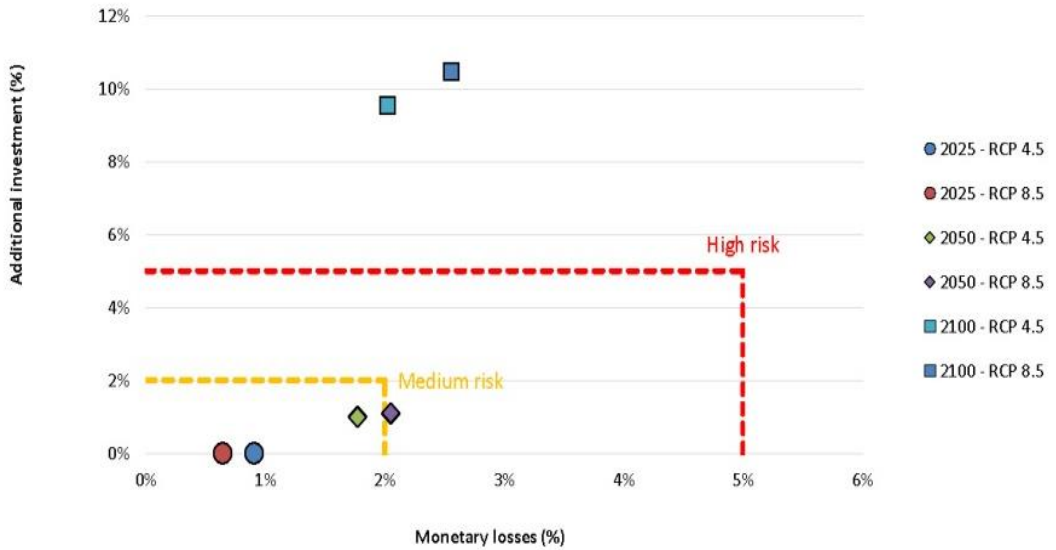
	SCENARIO					
	2025		2050		2100	
	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Additional investment (M USD)	0,00	0,00	2,16	2,38	20,84	22,87
Monetary losses (M USD) in scenario year	2,36	1,68	4,74	5,49	5,41	6,84
Expected revenue (M USD) in scenario year, without effects of cl. change	258,29	258,97	262,75	262,00	262,08	260,65

** If investments are made, in order to prevent monetary losses, monetary losses before investment could be greater than losses in scenario year.*

Additional investment (%) *(As % of increase over initial investment)*	0,00%	0,00%	0,99%	1,09%	9,54%	10,47%
Monetary losses (%) *(As % of planned revenue)*	0,91%	0,64%	1,77%	2,05%	2,02%	2,56%

RISK ASSESSMENT	SCENARIO					
	2025		2050		2100	
	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Additional investment	LOW RISK	LOW RISK	LOW RISK	LOW RISK	HIGH RISK	HIGH RISK
Monetary losses	LOW RISK	LOW RISK	LOW RISK	MEDIUM RISK	MEDIUM RISK	MEDIUM RISK
Combined risk assessment	LOW RISK	LOW RISK	LOW RISK	MEDIUM RISK	HIGH RISK	HIGH RISK

GRAPHIC ASSESSMENT



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INITIAL SET OF ADAPTATION OPTIONS

BEST ADAPTATION PATHWAY

MULTI-CRITERIA & COST-BENEFIT ANALYSIS

IMPLEMENTATION OF ADAPTATION MEASURES

RISK RE-ASSESSMENT

PORTS Emergency flood protection elements

Climate drivers

- Increase in extreme precipitation
- Increase in extreme sea level (waves, storm surges)

Intervention

Good supply of temporary flood barriers, water pumps, sandbags.

CAPEX Cost (as % of CAPEX)

2.00%

OPEX Cost (as % of OPEX)

Effectiveness

HIGH

Criticality

HIGH

Technical difficulty

MEDIUM

Cost-Efficiency index

HIGH

Climate Change related effects

- Flooding
- High precipitation

Benefits

It will avoid water ingress in storage buildings and other facilities, preventing load loss and electrical network damage.

Image for internal use only.

Climate Change impacts

- Increase in the number of flooding events, leading to building, cranes and other port element damage; the covering in debris of the entire port surface; port surface pollution; and damage of the power network

Percentage of the measure cost that can be qualified as adaptation

100 %

If the Project design has already considered this measure, the corresponding cost of the upgrade can be qualified as adaptation.

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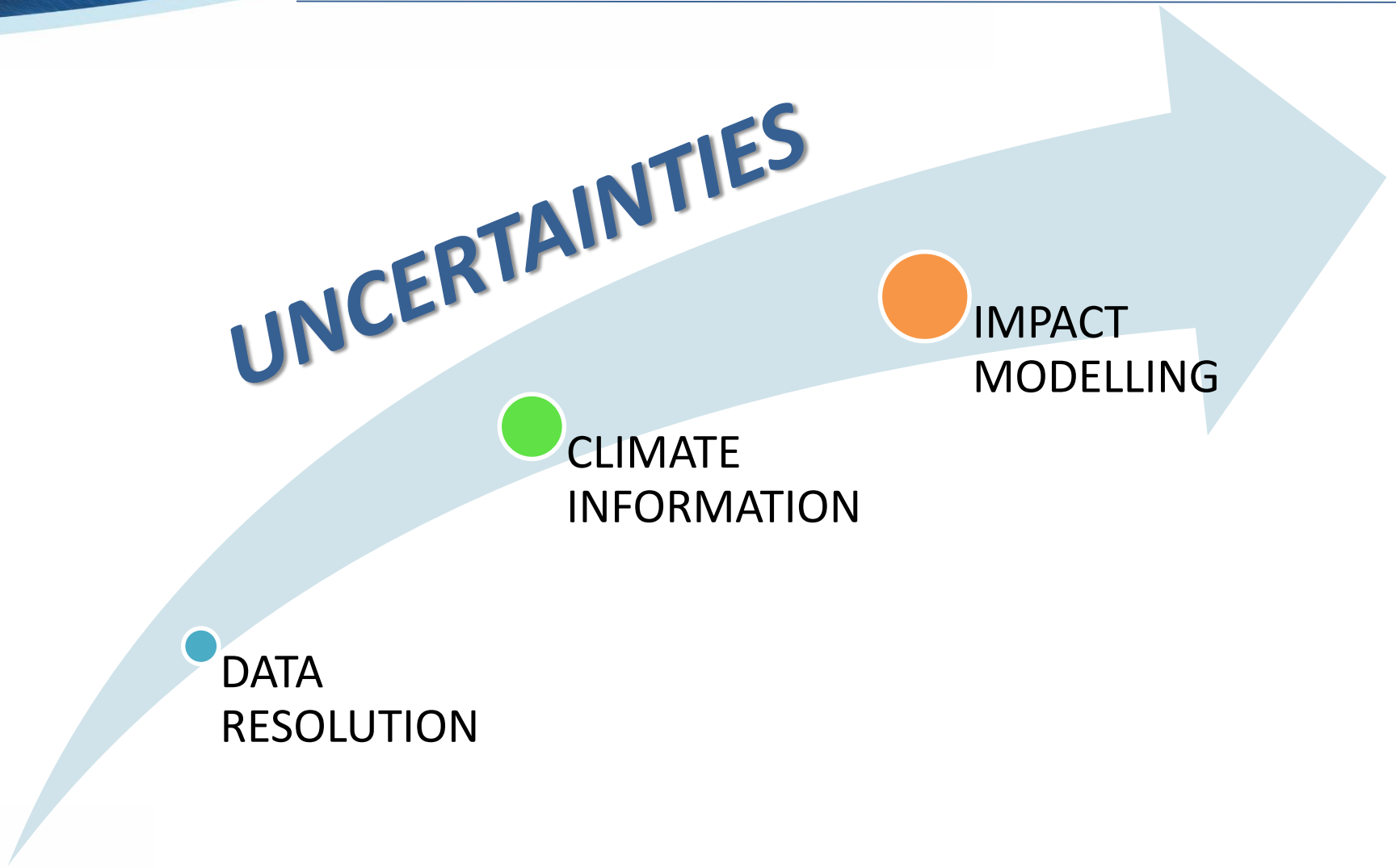
Creating Markets, Creating Opportunities

Louis Berger IH cantabria


UNCERTAINTIES
IMPACT MODELLING
CLIMATE INFORMATION
DATA RESOLUTION

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CONCLUSIONS

- ✓ We have developed a **THREE-LEVEL METHODOLOGY** addressing climate risk analysis in ports that provides the necessary information to adopt adaptation solutions.
- ✓ The approach presents the advantage of **OPTIMIZING RESOURCES AND CAPACITIES** to develop the most relevant assessment for the necessities of the port.
- ✓ The pre-diagnosis and high-resolution levels are based on the **IPCC CLIMATE CHANGE RISK FRAMEWORK** that integrates the three components of risk: hazard, exposure and vulnerability.
- ✓ We propose to split up the port into subsystems, based on the value chain, and identified **MULTI-HAZARD AND IMPACTS** in each one.
- ✓ The **PRE-DIAGNOSIS** level is based on hazard and impact **INDICATORS** while the **HIGH-RESOLUTION LEVEL** is focuses on statistical or dynamical downscaling of climate hazards and impact modelling based on **PROCESS-BASED MODELS**.
- ✓ The pre-diagnosis level has been implemented in a **SCREENING TOOL FOR THE GLOBAL SCALE** within the framework of a project funded by the International Finance Corporation.

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MULTILEVEL METHODOLOGY TO ADDRESS CLIMATE CHANGE RISK IN PORTS

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