PIANC APAC 2022 Conference
Melbourne 4-7 September 2022

Waterborne transport, ports and waterways: A 2021 update of climate change drivers and impacts

Presentation – Ron Cox

Honorary Associate Professor UNSW

PIANC Australia & New Zealand Board Member

Member PIANC international EnviCom, PTGCC, CoCom

Chair Paper Selection Committee – APAC 2022 and PIANC COPEDEC conferences

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PIANC Declaration on Climate Change released prior to COP25, Madrid, Dec 2019

The climate is changing. The evidence is unequivocal. ……..It is time to reinforce the message and upscale prudent action.

Waterborne transport infrastructure will be adversely affected by climate change ….. owners and operators need to take urgent action to reduce GHG emissions ….. strengthen resilience and adapt …… to gradual changes such as temperature and sea level ….. and to increases in the frequency and severity of extreme events.

PIANC recognises the importance of the climate change challenge and will actively pursue the sustainable future of the waterborne transport industry by supporting its members in addressing this challenge.

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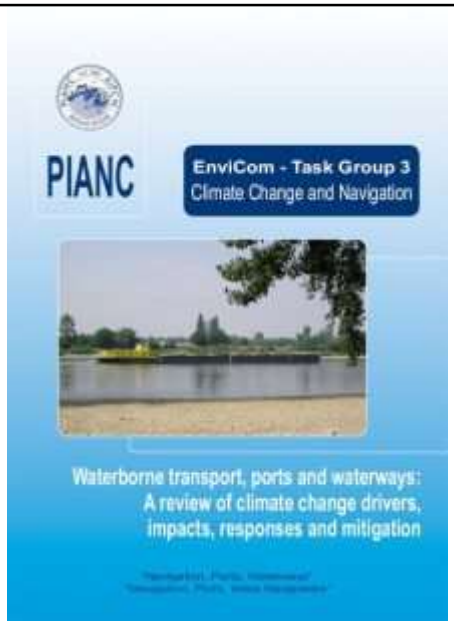
PIANC EnviCom TG 3:
Climate Change and Navigation - Waterborne Transport, Ports and Waterways: A Review of Climate Change Drivers, Impacts, Responses and Mitigation (2008)

Chair –Kathleen White, USACE



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3

PIANC Task Group 3 Report Climate change and navigation 2008

Common platform for all PIANC activities - **based on IPCC AR4 (2007)**

Climate drivers :- higher temperatures; sea level rise, tides and surge; wind and wave action; ocean circulation and coastal hydrodynamics; ocean, coastal, estuarine and river morphology; intense storm events; inland water resources and quality; sea chemistry, environment and ecology; ice conditions and icing.

Climate change impacts on maritime and inland navigation infrastructure and operations

Potential adaptation and mitigation responses identified.

Navigation contributions to greenhouse gas (GHG) emissions discussed, along with opportunities for reductions - eg use of alternative fuels

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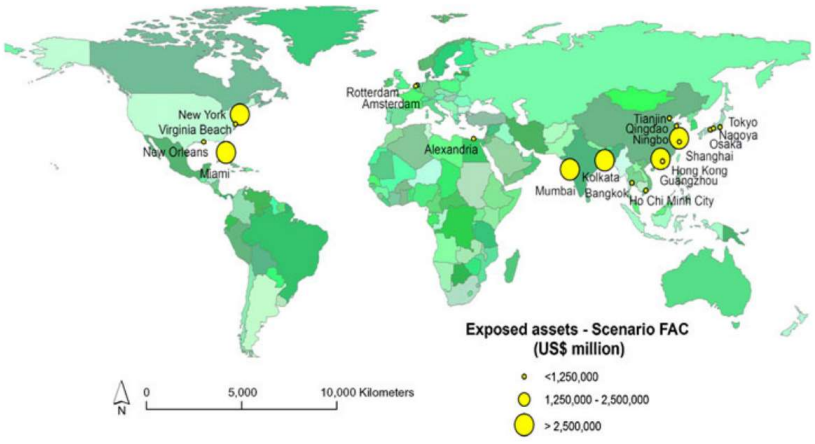
Hanson et al. (2011) identified the top 20 port cities with exposed assets under future climate (2070) and socioeconomic change scenarios



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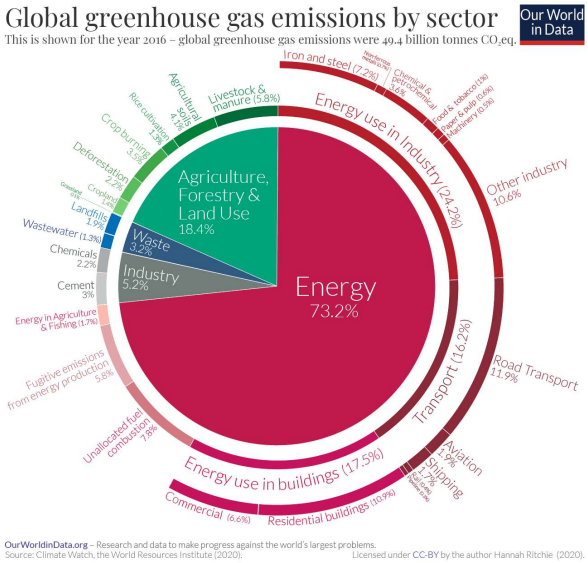
Transport	**16.2%**
Road	**11.9**
Air	**1.9**
Shipping	**1.7**
Rail	**0.4**
Pipeline	**0.3**



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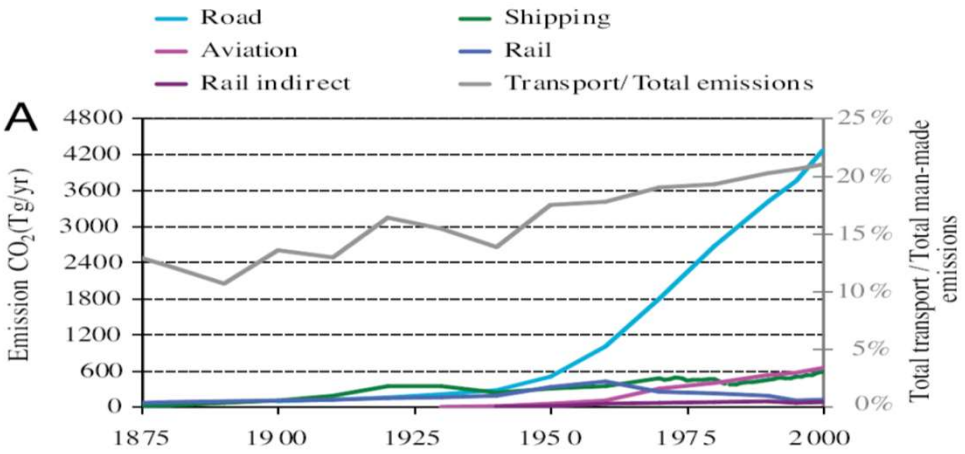
Mitigation – historical growth in CO2 across transport sector



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7

IPCC major updates of Climate science & adaptation

Since TG3 in 2008, IPCC has completed several major new reports :-

5th assessment report (IPCC AR5, 2013),

Special Report on Global Warming of 1.5°C (IPCC SR15, 2018),

Special Report on the Ocean and Cryosphere in a Changing Climate (IPCC SROCC, 2019)

6th assessment report (IPCC AR6, 2021).

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IPCC AR5 (2013)
Representative Concentration Pathways (RCPs)

AR5 introduced Representative Concentration Pathways (RCP's) in place of the Special Report on Emissions Scenarios (SRES) projections published in earlier IPCC reports

The RCPs represent emissions target levels for 2100 and comprise of four scenarios which include; a mitigation scenario leading to a low forcing level (RCP2.6), two medium stabilisation scenarios (RCP4.5/RCP6) and one high baseline emission scenario (RCP8.5).

The RCPs are represented as alternative emissions of global greenhouse gas and aerosol concentrations and are named after a possible range of radiative forcing values in the year 2100 relative to pre-industrial values

RCP8.5 represents a radiative forcing of 8.5 Watts/m^2 and is often referred to as "business as usual"

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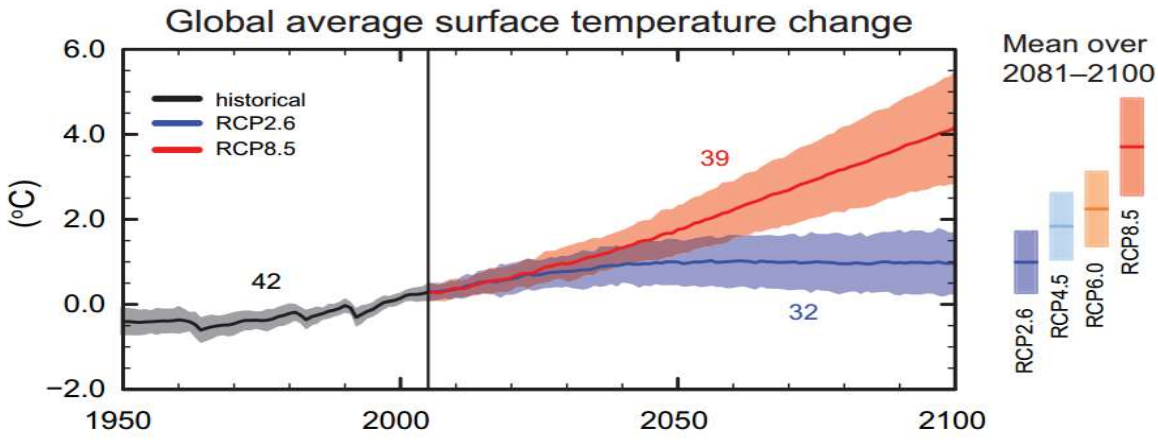
Increasing temperatures



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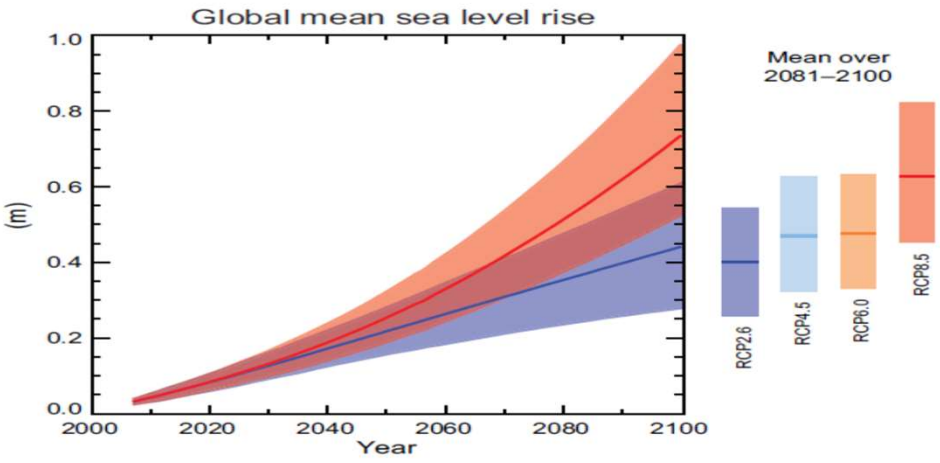
Rising sea levels



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Standard terms - levels of confidence (IPCC AR5, 2013)

Confidence terminology	Degree of confidence in being correct
Very high confidence	At least 9 out of 10 chance
High confidence	**About 8 out of 10 chance**
Medium confidence	About 5 out of 10 chance
Low confidence *(only used for areas of major concern and where a risk-based perspective is justified)*	**About 2 out of 10 chance**
Very low confidence (only used for areas of major concern and where a risk-based perspective is justified)	Less than 1 out of 10 chance

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Standard terms used to define the likelihood of an outcome or result where this can be estimated probabilistically (IPCC AR5, 2013)

Likelihood terminology	Likelihood of the occurrence/ outcome
Virtually certain	> 99% probability
Extremely likely	> 95% probability
Very likely	> 90% probability
Likely	**> 66% probability**
More likely than not	> 50% probability
About as likely as not	33 to 66% probability
Unlikely	**< 33% probability**
Very unlikely	< 10% probability
Extremely unlikely	< 5% probability
Exceptionally unlikely	< 1% probability

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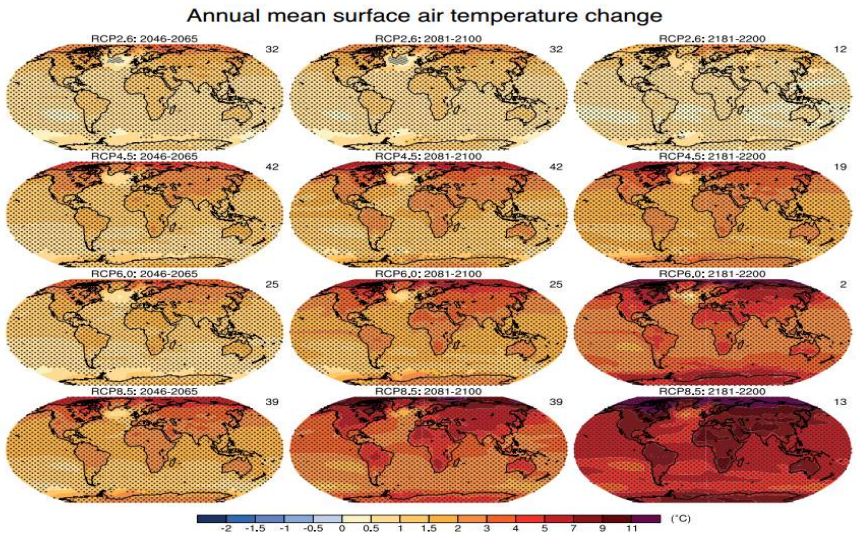
Regional differences with scenarios over time (AR5 Fig 12.11)



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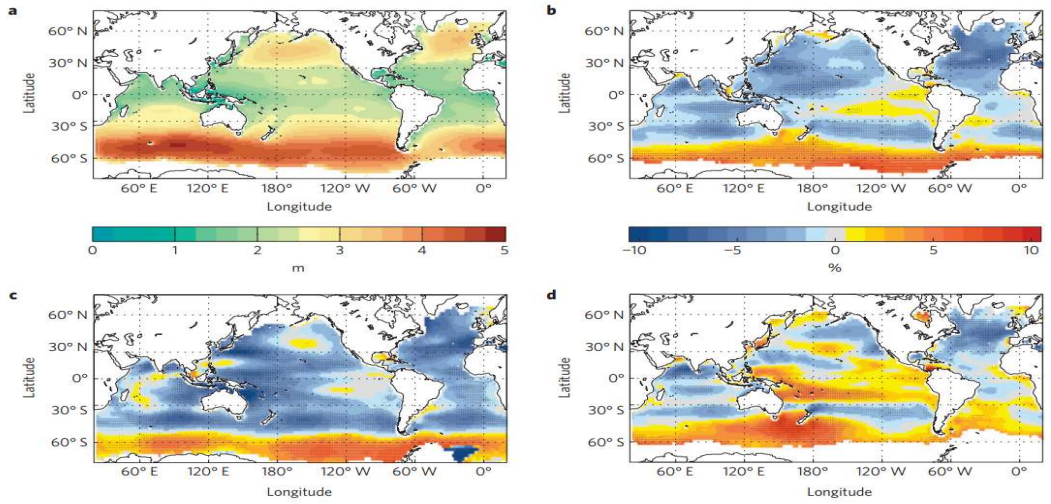
World wave height projections (Hemer etal 2013)

a present 1979-2009, b % annual change to 2070-2100, c JFM, d JAS



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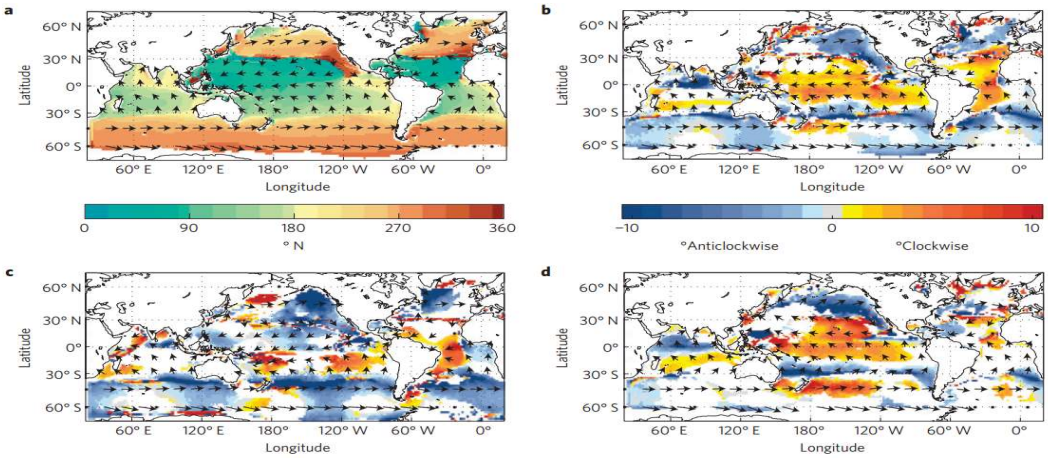
Changing wave direction >> shoreline alignments



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16

IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (IPCC SROCC, 2019)

The IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (IPCC SROCC, 2019) is particularly relevant to the navigation sector as it specifically looks in detail at oceans and the cryosphere (sea and ice).

Figure SPM-1from IPCC SROCC, (2019) summarises some of the important climate and system projected responses: complex figure with much information

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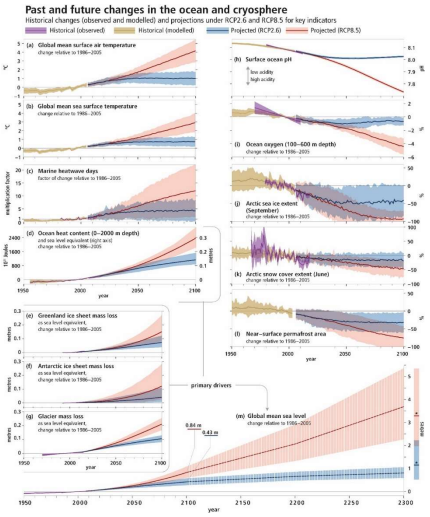
Past and future changes in the oceans and cryosphere

(reproduced from IPCC SROCC, 2019 Figure SPM-1)



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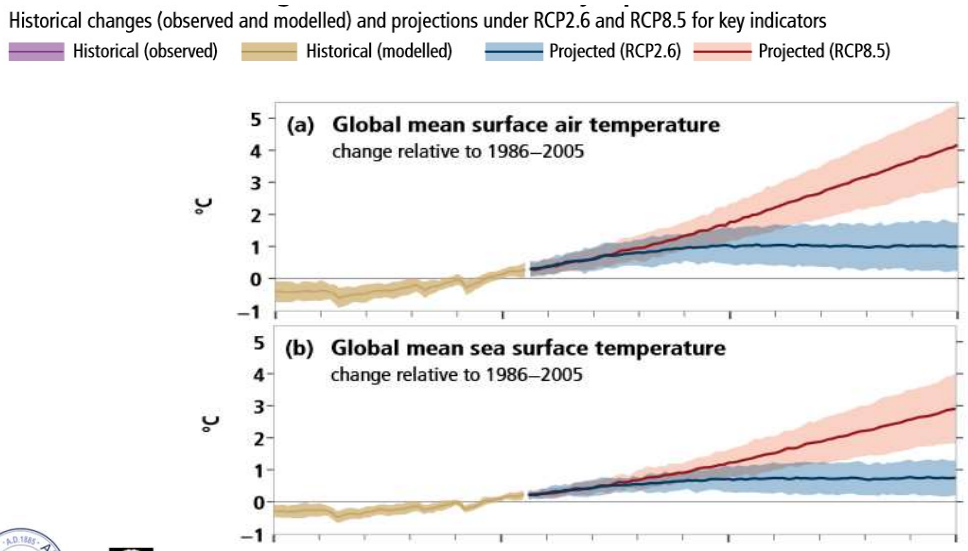
18

18

RCP8.5 to 2100 - 3to5 deg C in air – 2to4 deg C in sea



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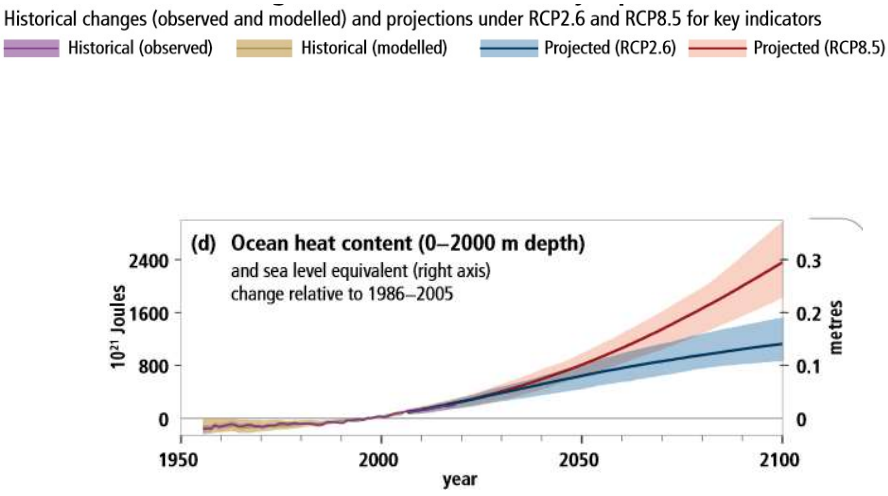
19

RCP 8.5 to 2100 – Ocean heat content 0.3m equivalent SLR



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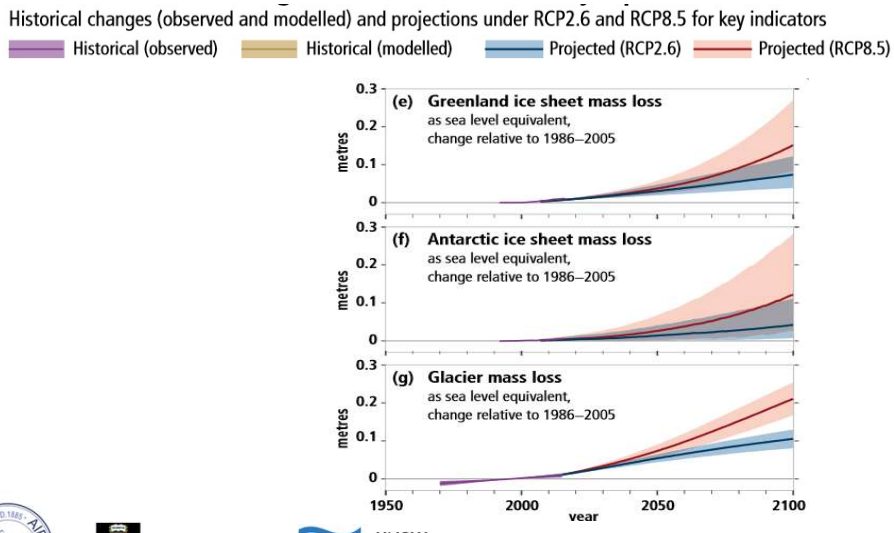
RCP 8.5 to 2100 – Ice sheet mass loss equivalent SLR



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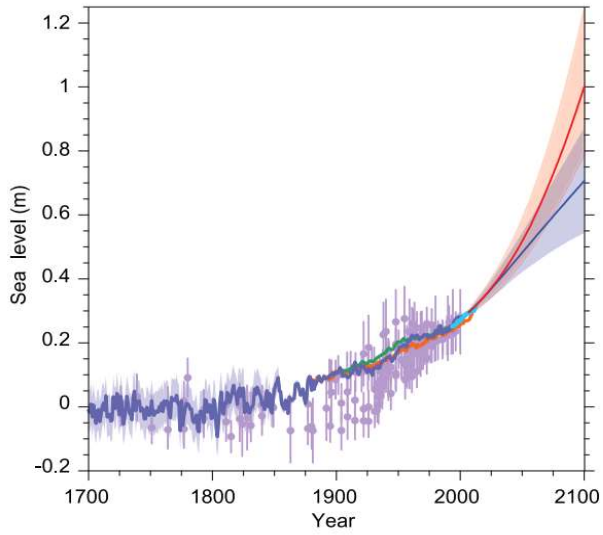
21

SLR – gauges, satellite and projections



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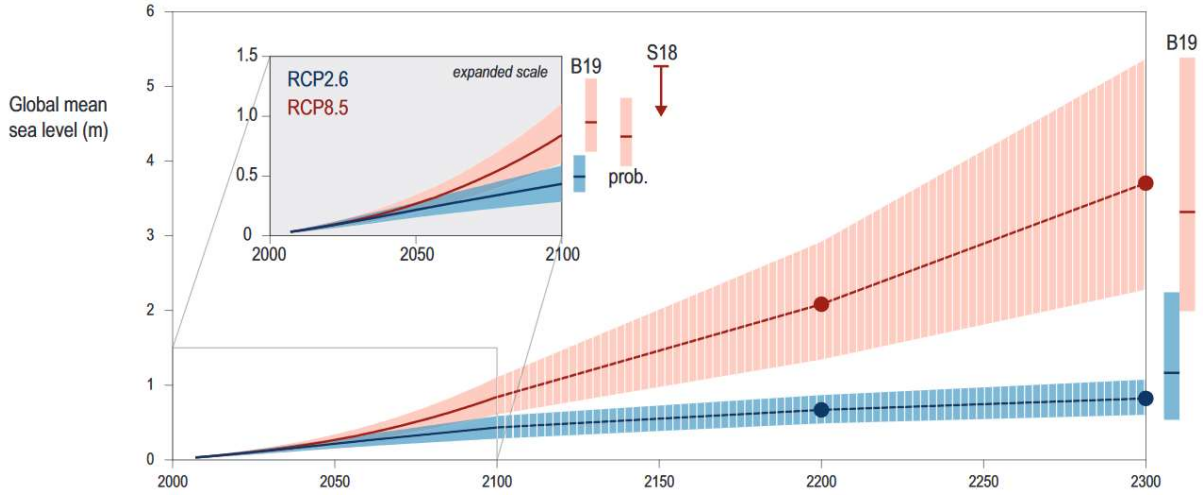
SLR RCP 8.5 – 0.8m to 2100 continues to increase in 2300 to 3.7m



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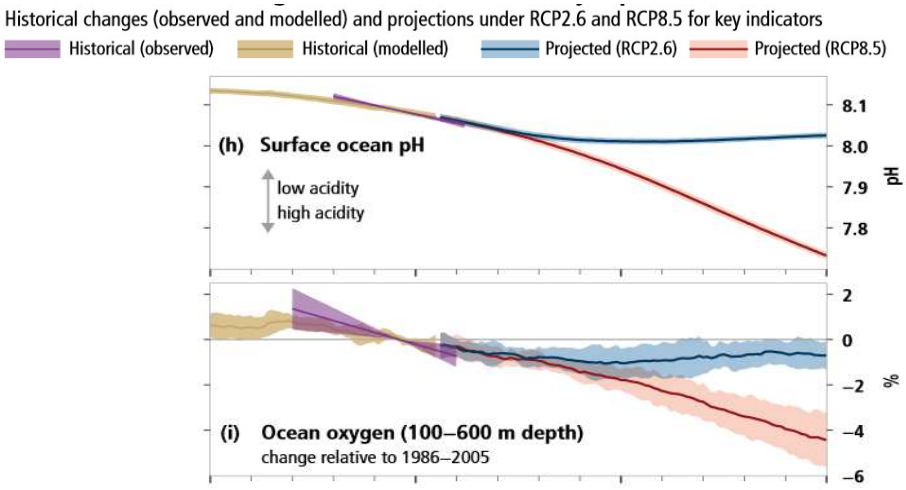
RCP 8.5 to 2100 – increased ocean acidity and reduced oxygen



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24

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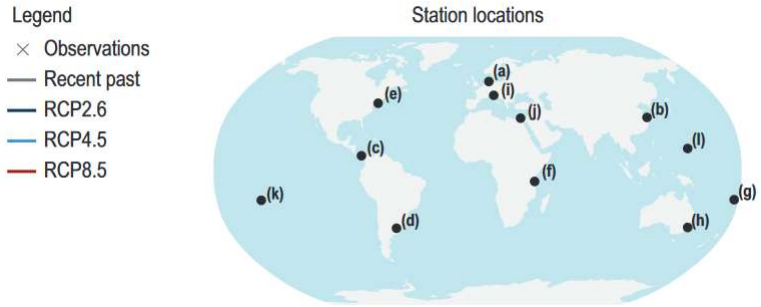
Extreme water levels – SLR , tide and surge (SROCC Fig 4.11)



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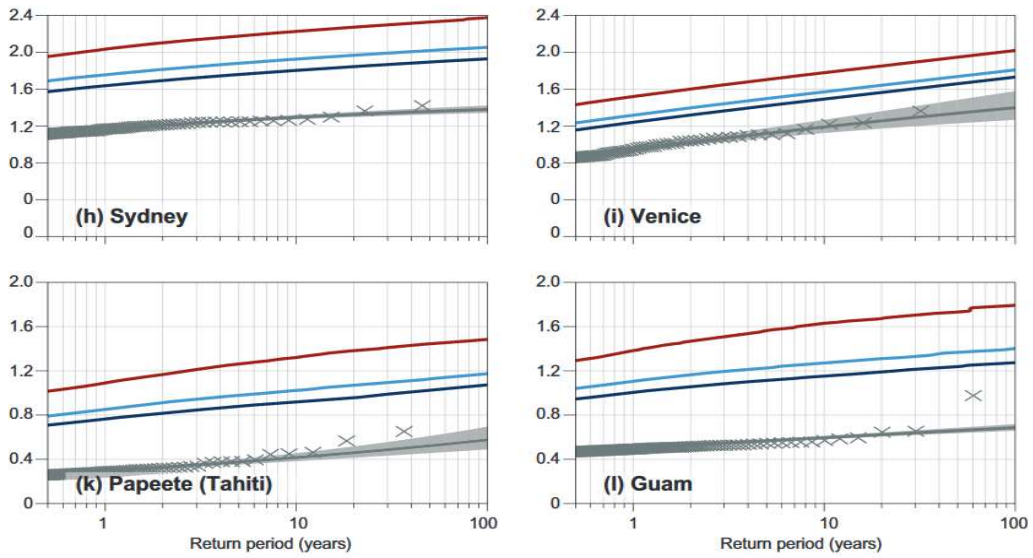
Extreme water levels – SLR , tide and surge (SROCC Fig 4.11)



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26

26

Update of Climate science with IPCC AR6 (2021)

GCCMs getting better with reduced uncertainty

Higher resolution with spatial and temporal variability

Global average changes from AR4 are however not great

Projections for 2100 suggest a global mean sea level rise of 0.4 to 0.8 m and a greater frequency and intensity of extreme weather events.

Even if emissions of greenhouse gases stop today, these changes would continue for many decades and in the case of the sea level for centuries.

Exaggeration of change – counterproductive

"Uncertainty" diminishes public acceptance

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IPCC AR6 (2021)
Shared Socio-economic Pathways (SSPs)

Since AR5, subsequent IPCC reports (SR15-2018 and SROCC-2019) used the four emission scenarios RCP 2.6, RCP 4.5, RCP 6.0, RCP 8.5.

BUT

IPCC AR6 (2021) introduced new terminology for scenarios

5 different scenarios named as Shared Socio-economic Pathways each encompassing a range of radiative forcing in the year 2100.

These range from a low SSP1-1.9 to very high SSP5-8.5 scenario.

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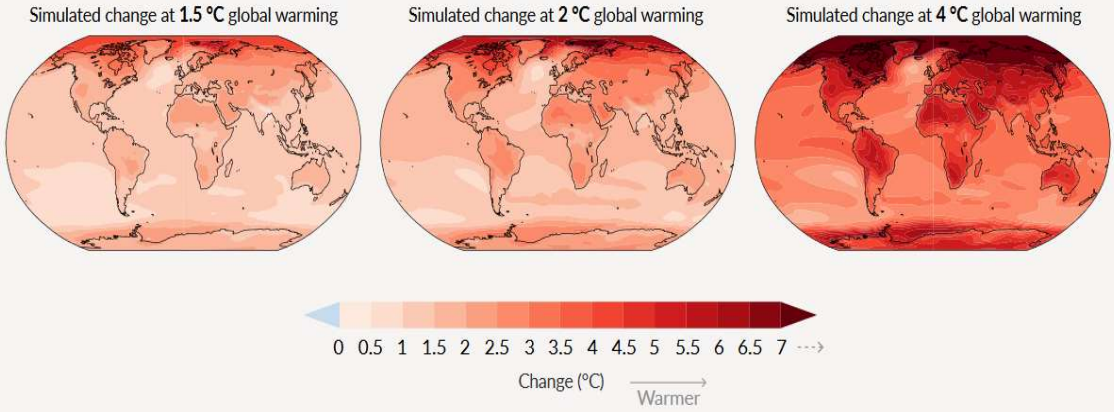
28

Regional differences in warming (AR6 Fig SPM.5b)

b) Annual mean temperature change (°C) relative to 1850-1900

Across warming levels, land areas warm more than oceans, and the Arctic and Antarctica warm more than the tropics.



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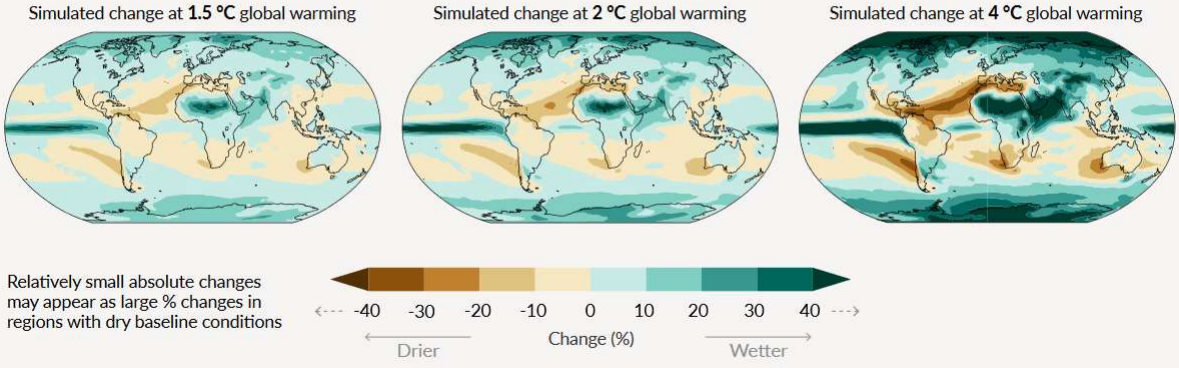
Regional differences in precipitation (AR6 Fig SPM.5c)

c) Annual mean precipitation change (%) relative to 1850-1900

Precipitation is projected to increase over high latitudes, the equatorial Pacific and parts of the monsoon regions, but decrease over parts of the subtropics and in limited areas of the tropics.



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Update to TG3 (2008) - for publication late 2022

Waterborne transport, ports and waterways: A 2022 update of climate change drivers and impacts

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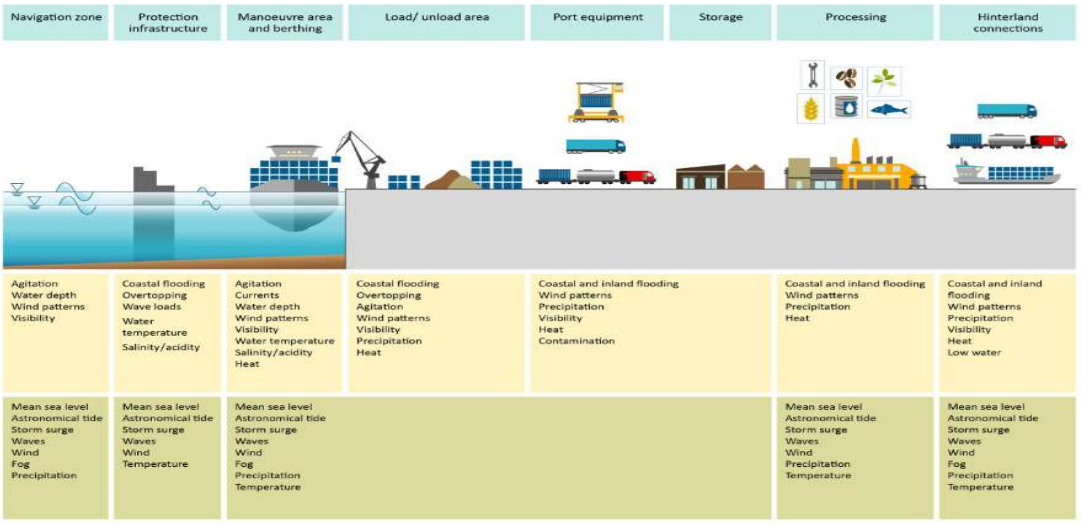
Climate interactions with port assets and operations – WG178



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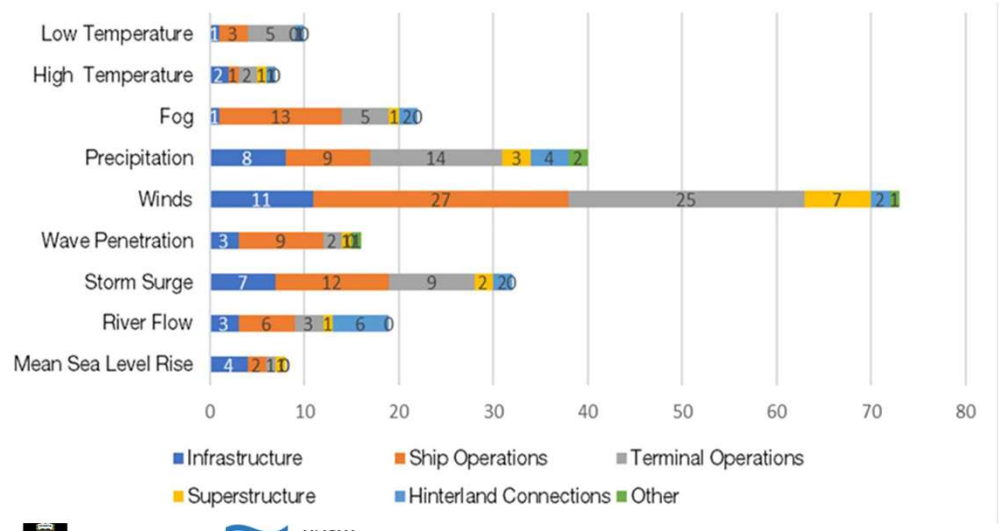
Impact of climate factors on port infrastructure, operations and services
UNCTAD (2017) survey



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33

Related recent PIANC reports

- EnviCom WG 178: Climate Change Adaptation Planning for Ports and Inland Waterways (2020)
- EnviCom TG193: Resilience of the Maritime and Inland Waterborne Transport System (2020)
- PTGCC Technical Note 1: Managing Climate Change Uncertainties in Selecting, Designing and Evaluating Options for Resilient Navigation Infrastructure (2022)
- EnviCom 188: Carbon Management for Port and Navigation Infrastructure (2019)

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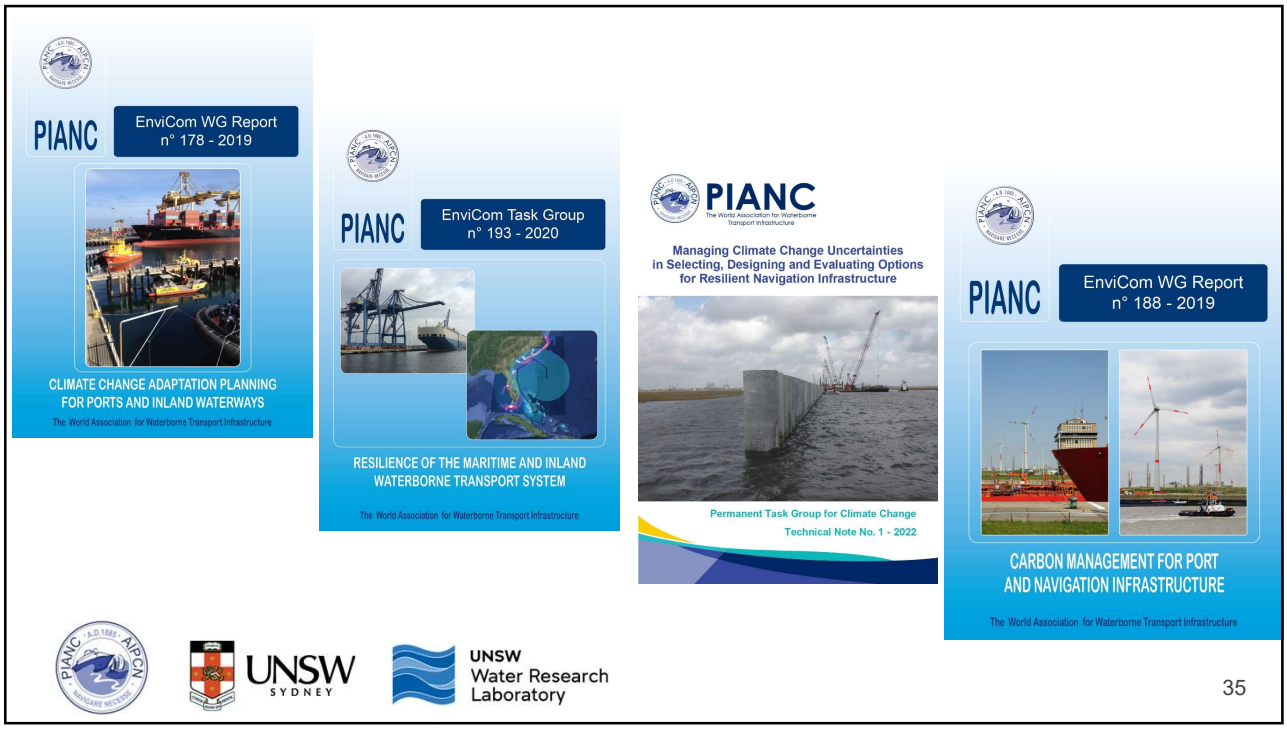
PIANC
EnviCom WG Report
n° 178 - 2019
CLIMATE CHANGE ADAPTATION PLANNING
FOR PORTS AND INLAND WATERWAYS
The World Association for Waterborne Transport Infrastructure
PIANC
EnviCom Task Group
n° 193 - 2020
RESILIENCE OF THE MARITIME AND INLAND
WATERBORNE TRANSPORT SYSTEM
The World Association for Waterborne Transport Infrastructure
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The World Association for Waterborne Transport Infrastructure
Managing Climate Change Uncertainties
in Selecting, Designing and Evaluating Options
for Resilient Navigation Infrastructure
Permanent Task Group for Climate Change
Technical Note No. 1 - 2022
PIANC
EnviCom WG Report
n° 188 - 2019
CARBON MANAGEMENT FOR PORT
AND NAVIGATION INFRASTRUCTURE
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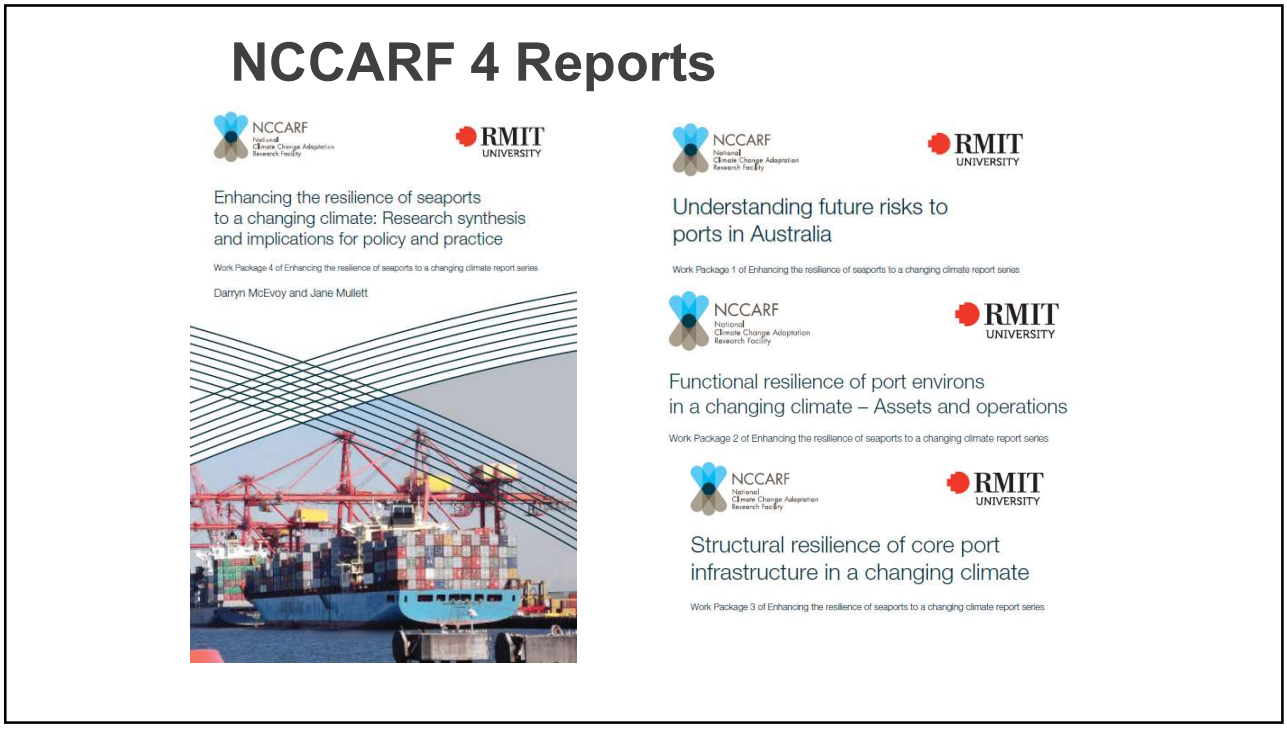
NCCARF 4 Reports
NCCARF
National Climate Change Adaptation Research Facility
RMIT
UNIVERSITY
Enhancing the resilience of seaports
to a changing climate: Research synthesis
and implications for policy and practice
Work Package 4 of Enhancing the resilience of seaports to a changing climate report series
Darryn McEvoy and Jane Mullett
Understanding future risks to
ports in Australia
Work Package 1 of Enhancing the resilience of seaports to a changing climate report series
Functional resilience of port environs
in a changing climate – Assets and operations
Work Package 2 of Enhancing the resilience of seaports to a changing climate report series
Structural resilience of core port
infrastructure in a changing climate
Work Package 3 of Enhancing the resilience of seaports to a changing climate report series

36

Scenario analysis and stress testing to include climate change

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37

Accidents still happen !

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38

38

Concluding remarks

Under current circumstances (and without both substantially increased carbon reduction targets under the Paris Agreement and accelerated development of negative emission technologies) neither the RCP2.6 nor the 1.5°C warming targets are likely to be achieved.

In addition to contributing to international and national action on emissions reduction (PIANC WG188, 2019), the owners and operators of waterborne transport infrastructure need to take urgent action to strengthen resilience and adapt navigation assets and activities (PIANC WG178, 2020).

In planning for climate change, it is important that decision making includes sensitivity testing of outcomes to the full range of possible scenarios over various time periods.

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39

39

Questions

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40

40