Eco-Asset Management Symposium

Comox – Courtenay Estuary Coastal Floodplain

15 March 2017

Outline

Setting

Climate Change and Sea Level Rise Expectations

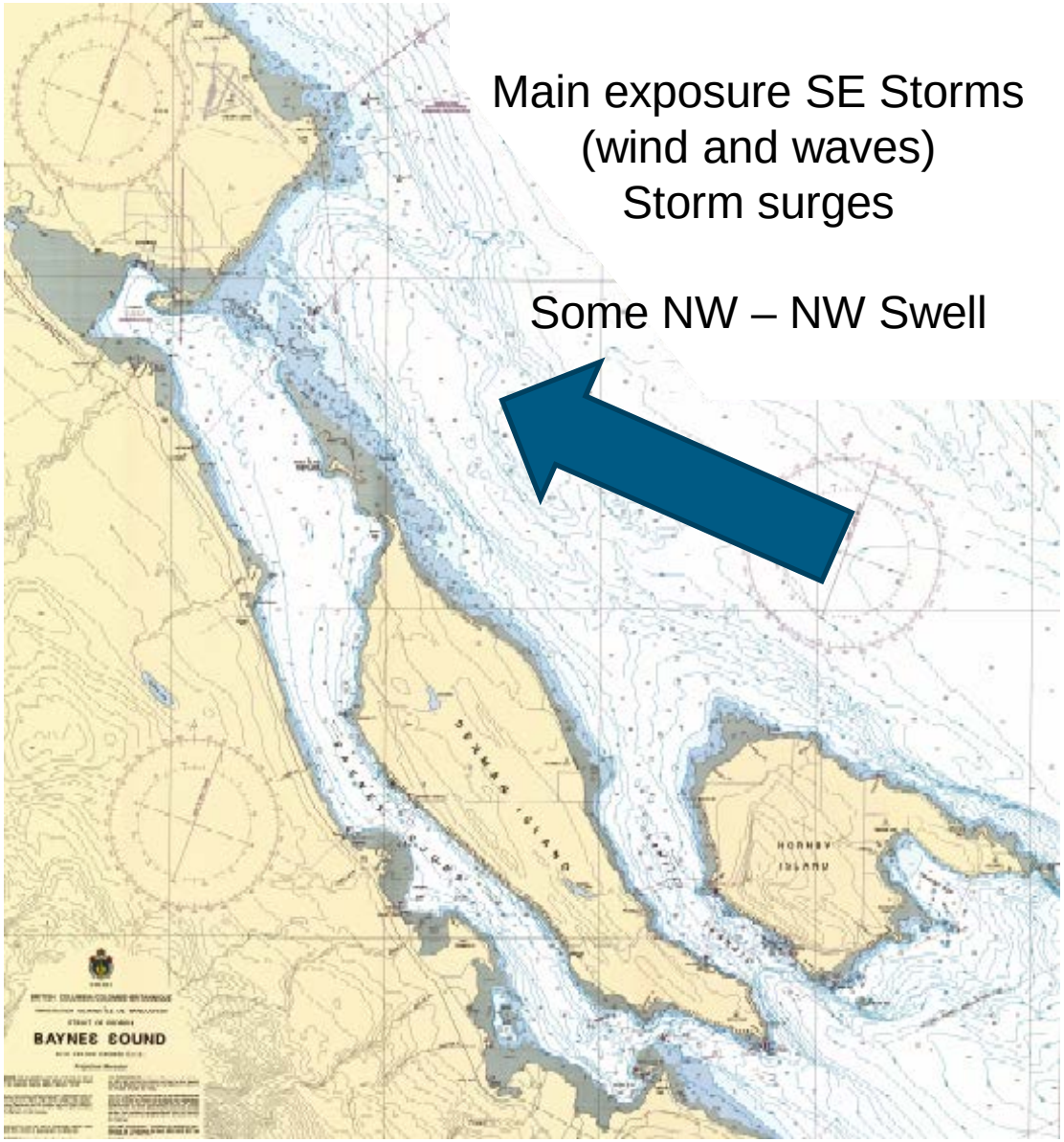
Implications to Comox – Courtenay Coastal Floodplain

Eco-Assets

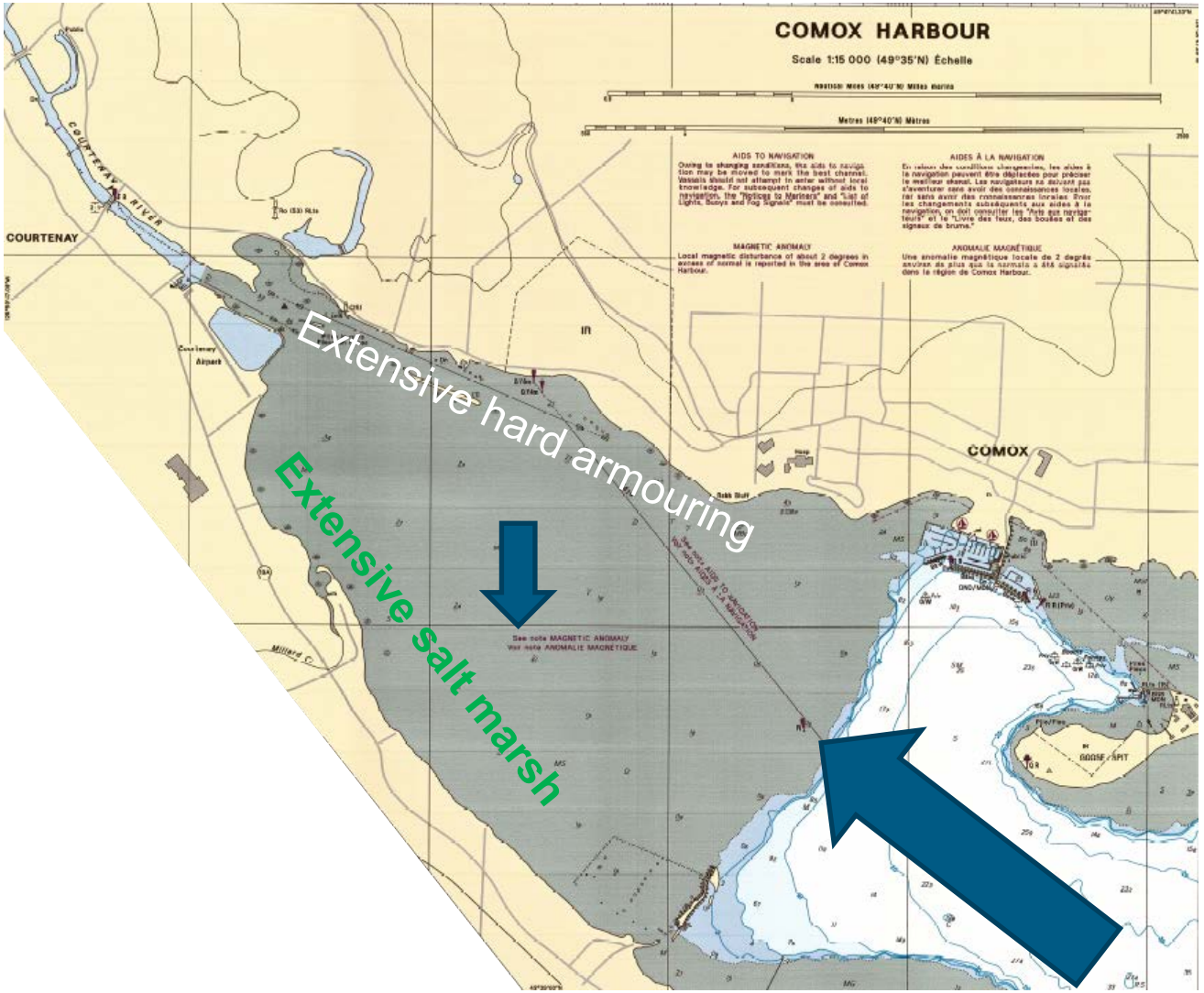
Options and Alternatives for Adaptation

Setting

Regional Setting



Local Area

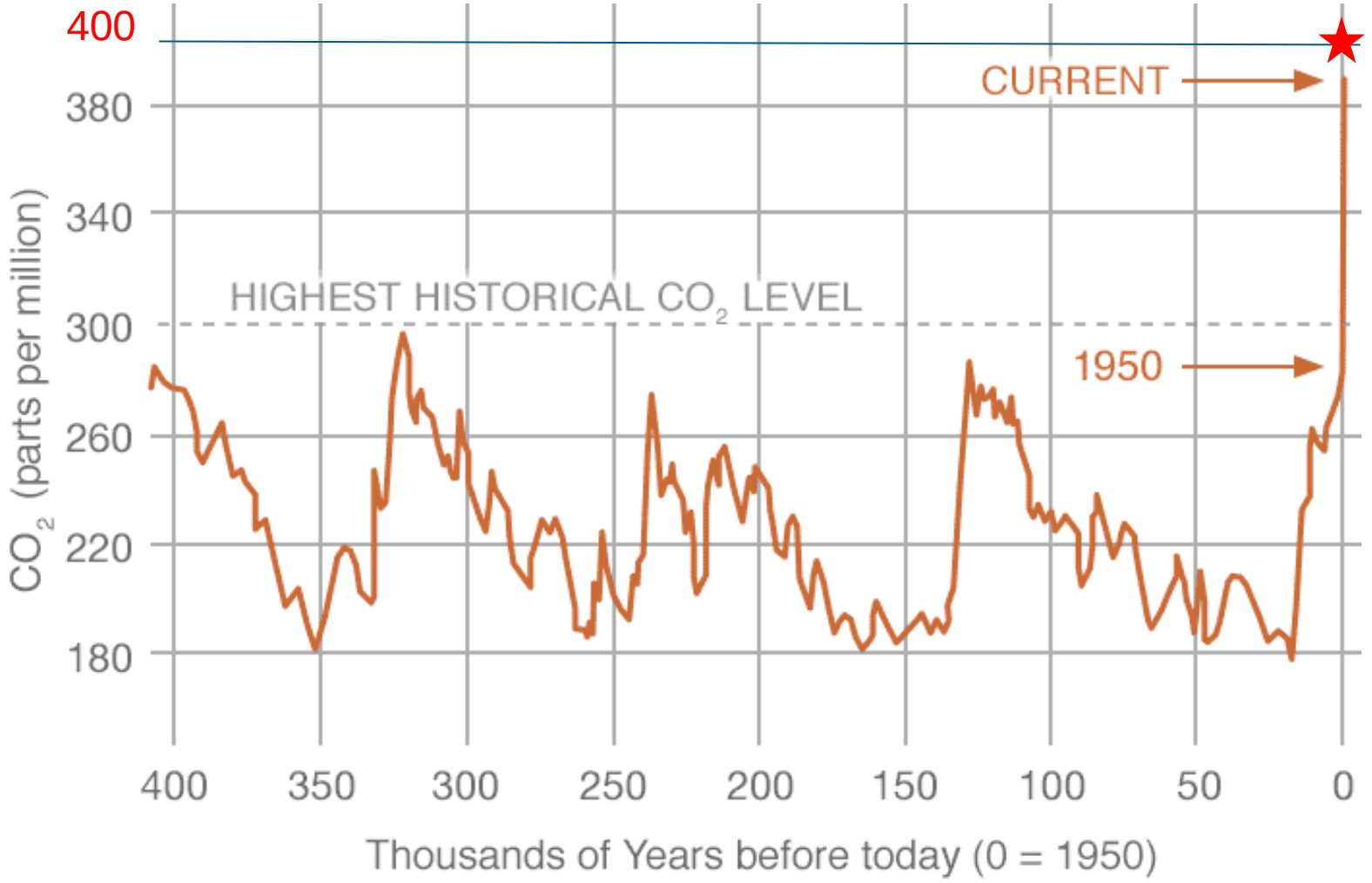

COMOX HARBOUR
Scale 1:15 000 (49°35'N) Échelle
COURTENAY
COMOX
Extensive hard armouring
Extensive salt marsh

Local Area


River discharge
Agricultural land and transportation infrastructure
Extensive development

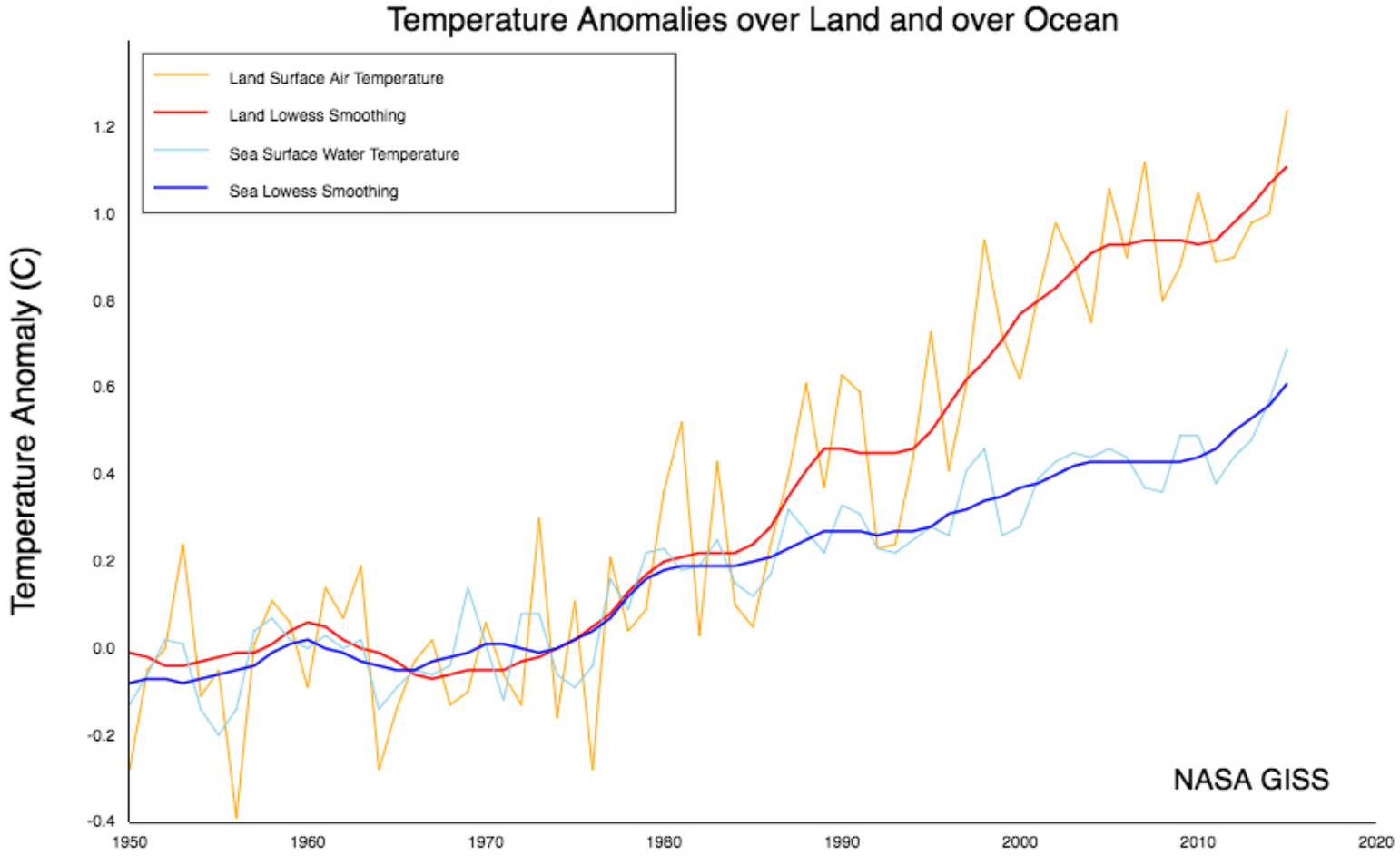
Climate Change Update

CO_2 Background



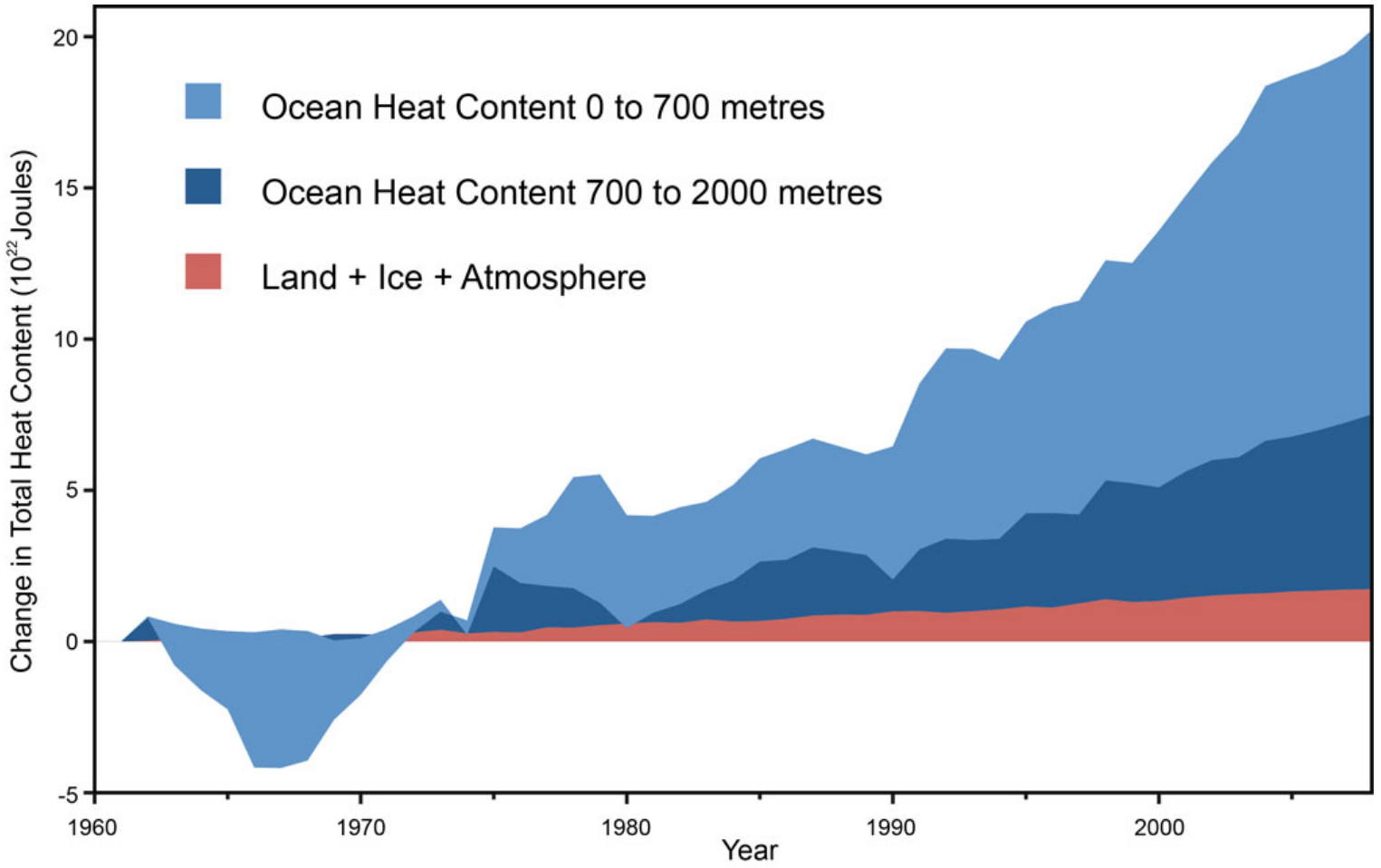
Data source: Reconstruction from ice cores.
Credit: NOAA/NASA

Present Temperature Trends



Credit: NASA GISS (October 2016)

Air and Ocean Temperatures



source: Nuccitelli et al., 2012)

Influence of Warming Ocean Temperatures

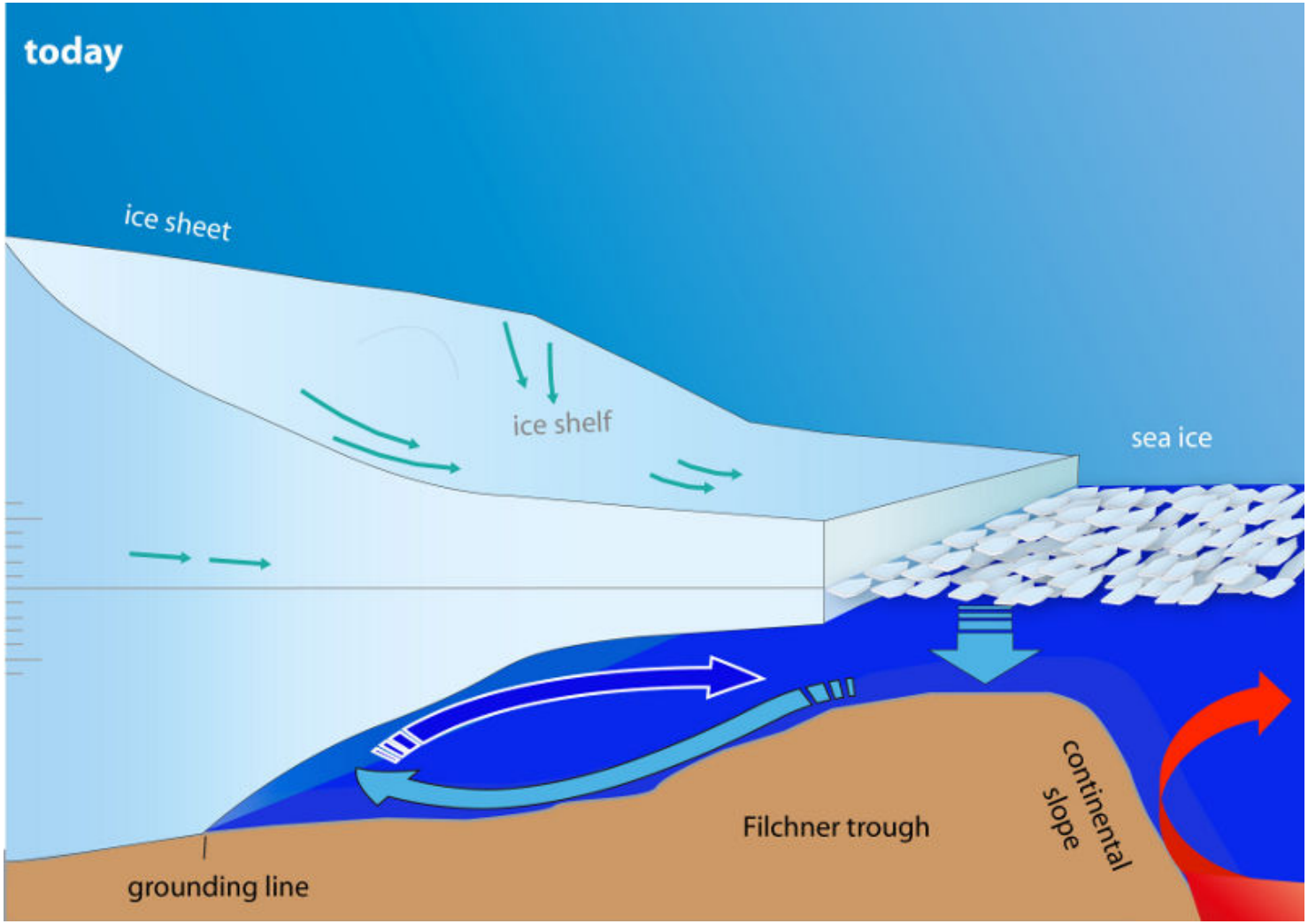
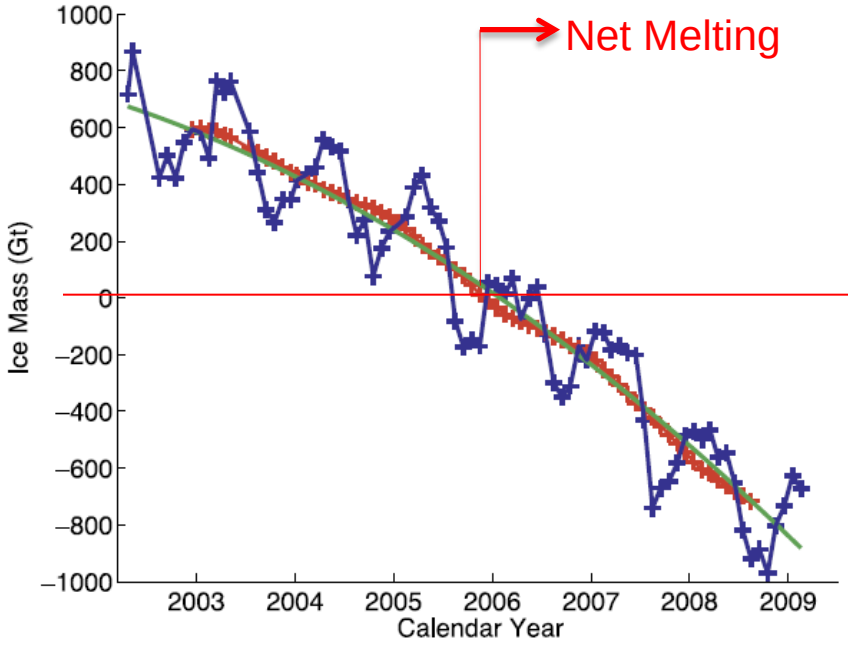


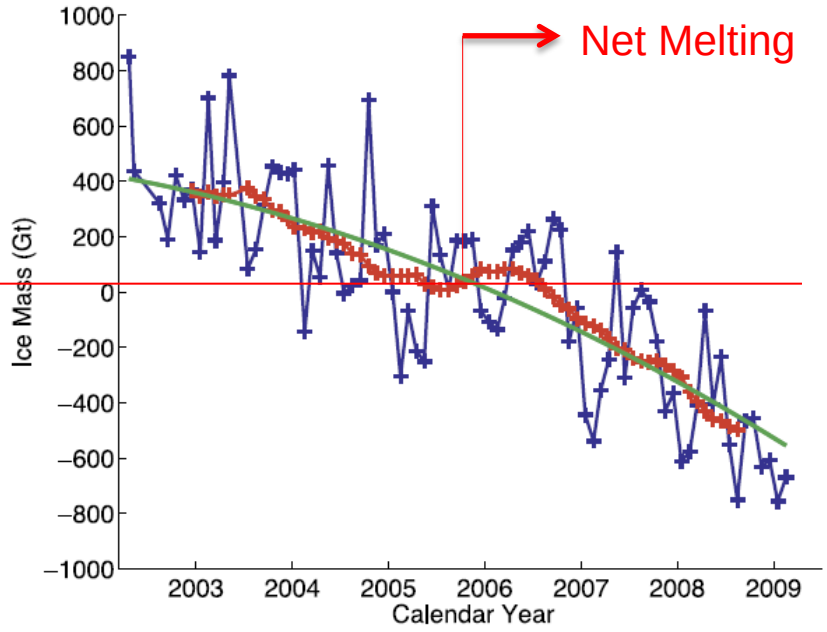
Image credit: Climate Citizen

Melting of Large Ice Sheets

Greenland Ice Sheet



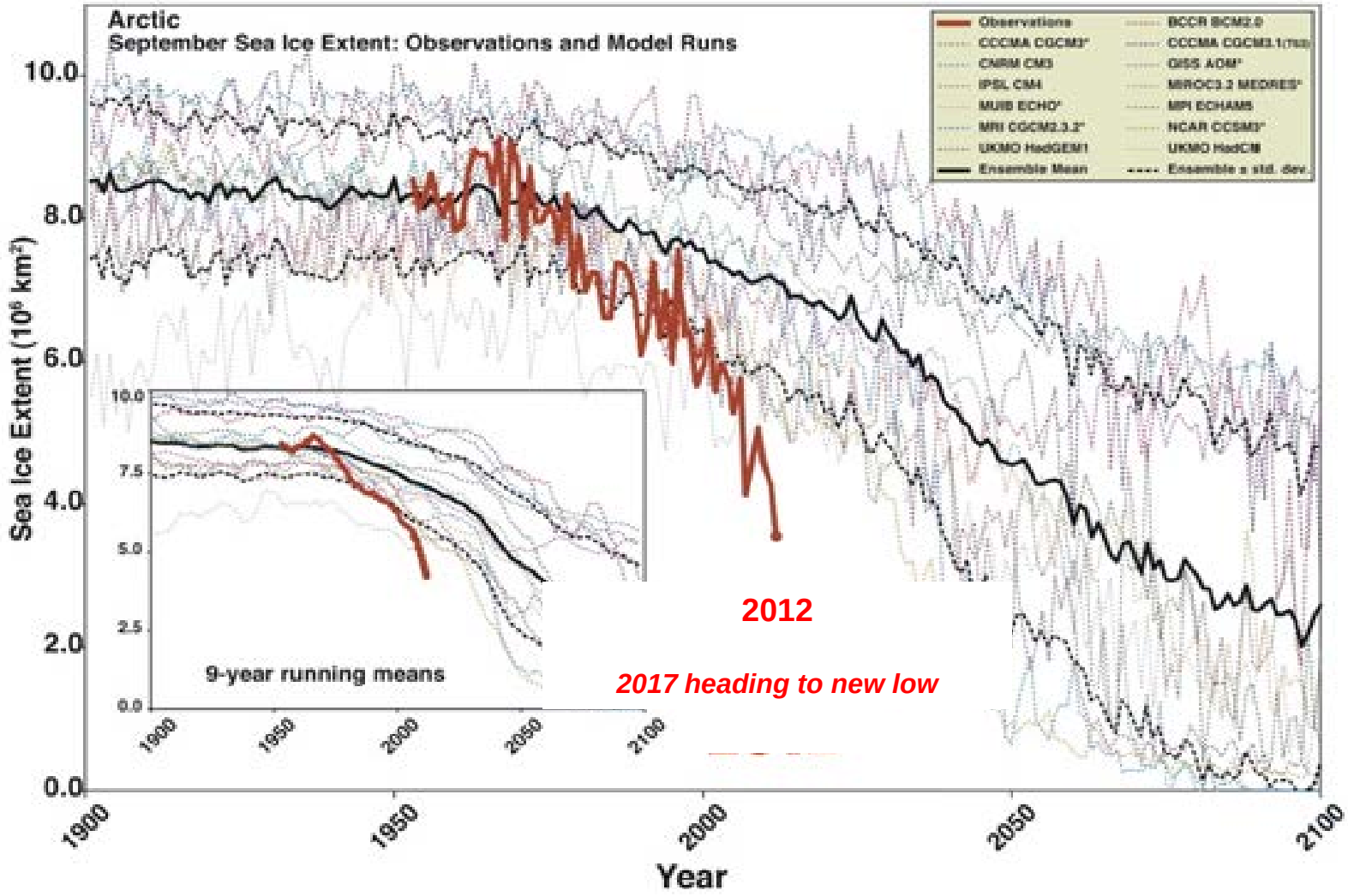
Antarctic Ice Sheet



In 3 years – 10% of the way (15,000 Gt melting) to 1 m SLR

Source: Velicogna, I. *Geophys. Res. Lett.*, **36**, L19503, doi:10.1029/2009GL040222, 2009.

Arctic Ice Sheet Melting



Credit: adapted from National Snow and Ice Data Centre

Arctic Warming

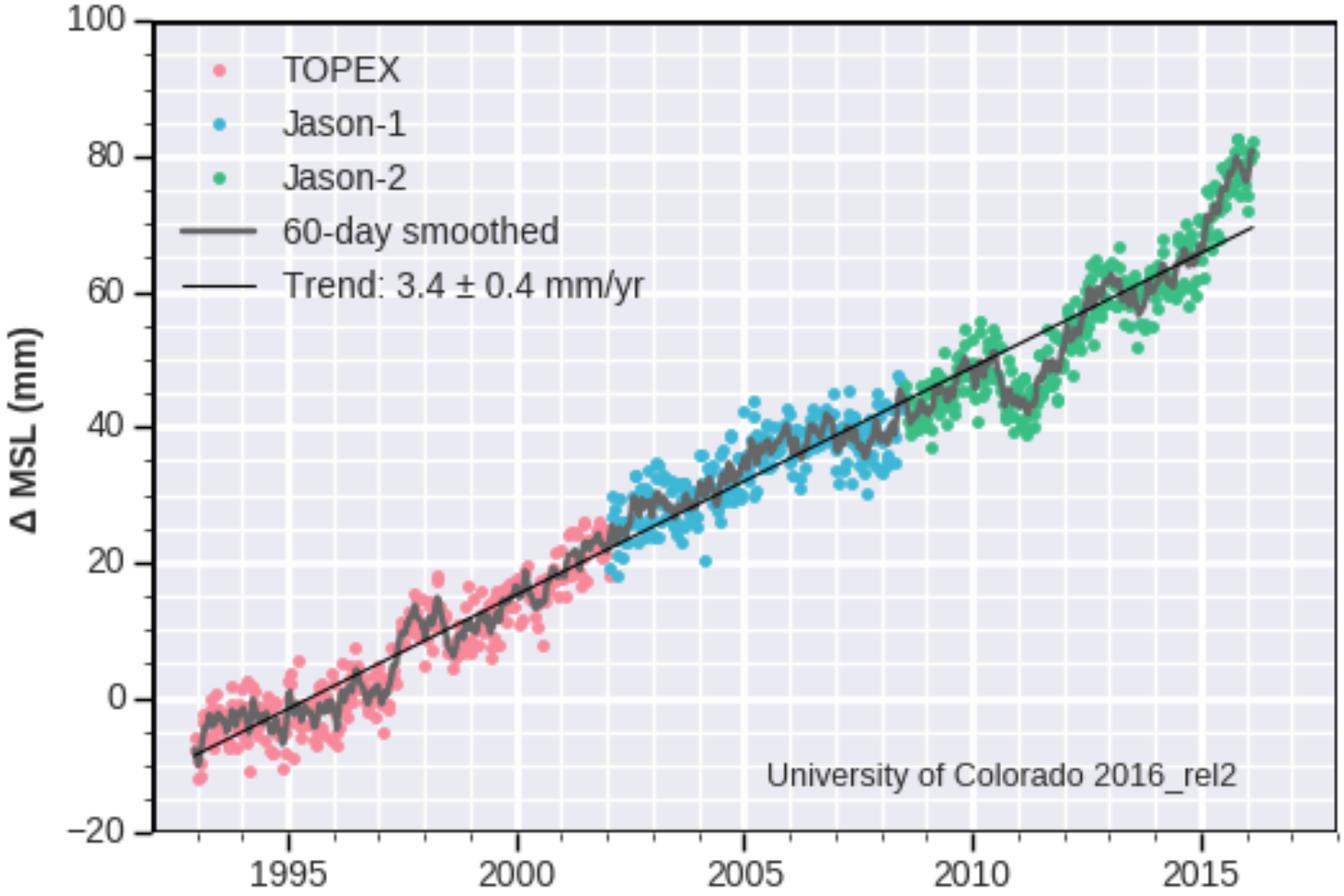
-Arctic warming changing and slowing the jet stream

-Upper atmosphere weather systems stalling or progressing more slowly:

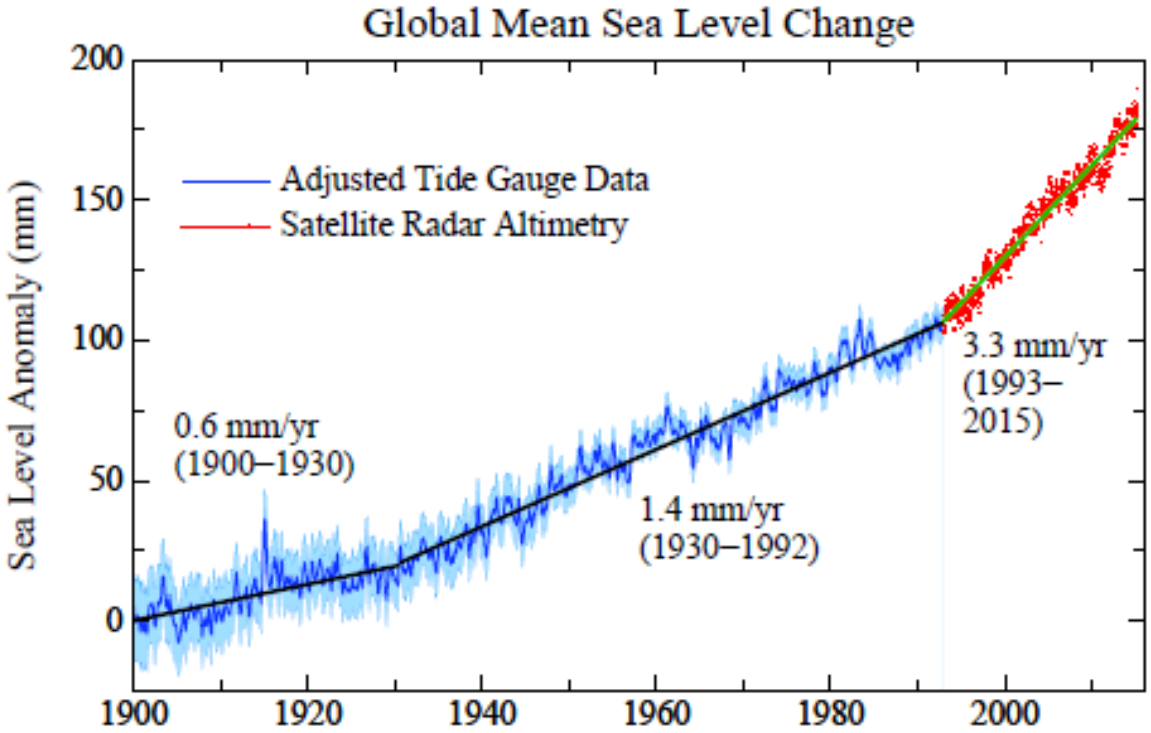
- Prolonged snowy winters in Europe
- Extended drought in SW USA
- Cold snowy winters in E North America
- Recurring easterly moisture laden winds in Prairies (2002, 2005 and 2013)
- Prolonged Warm Pacific NW weather

-Increasing occurrence of persistent (stalled) weather

Recent Mean Sea Level Rise



Historical Pace of SLR



From Hansen et al (2015) – reflecting work by Hay et al (2015)

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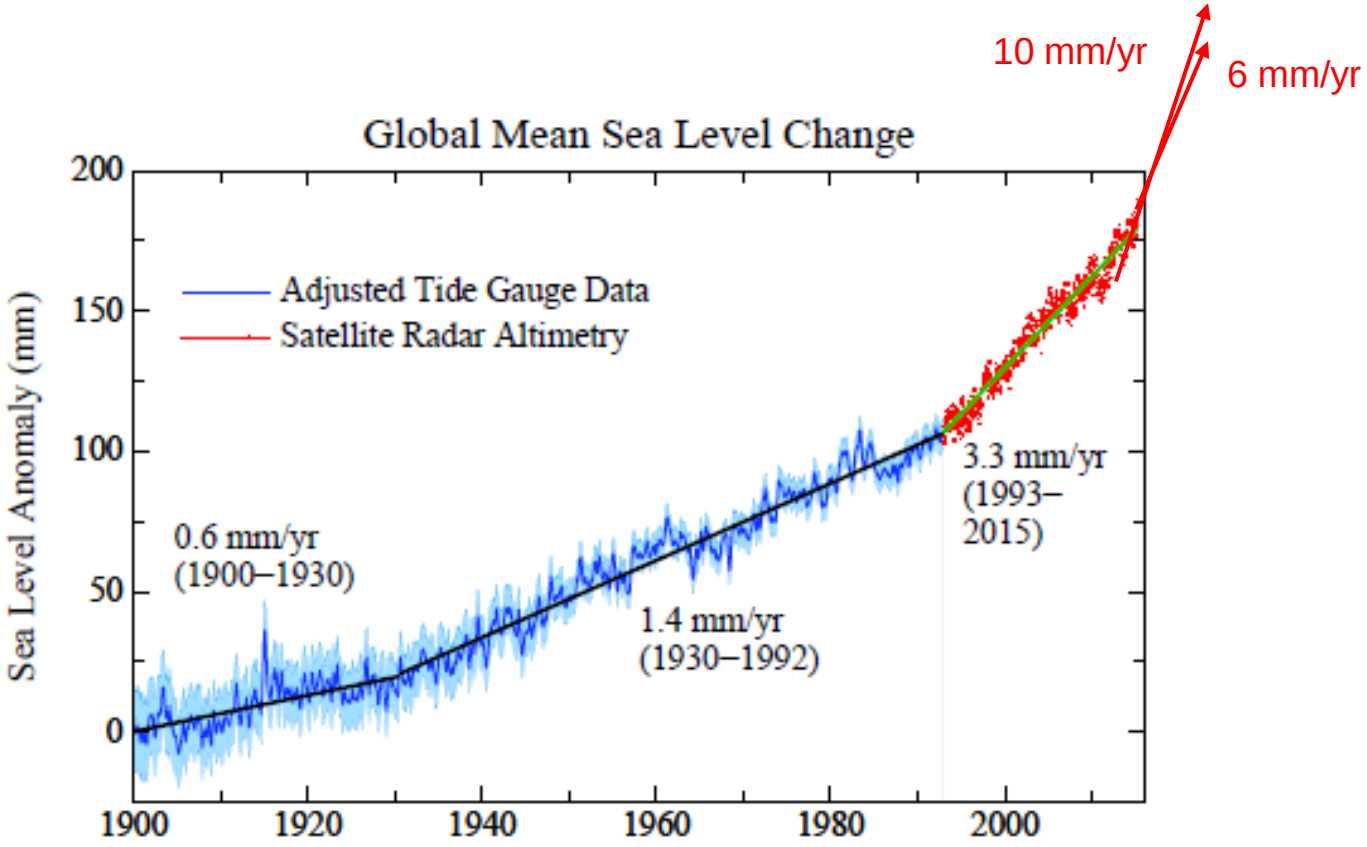

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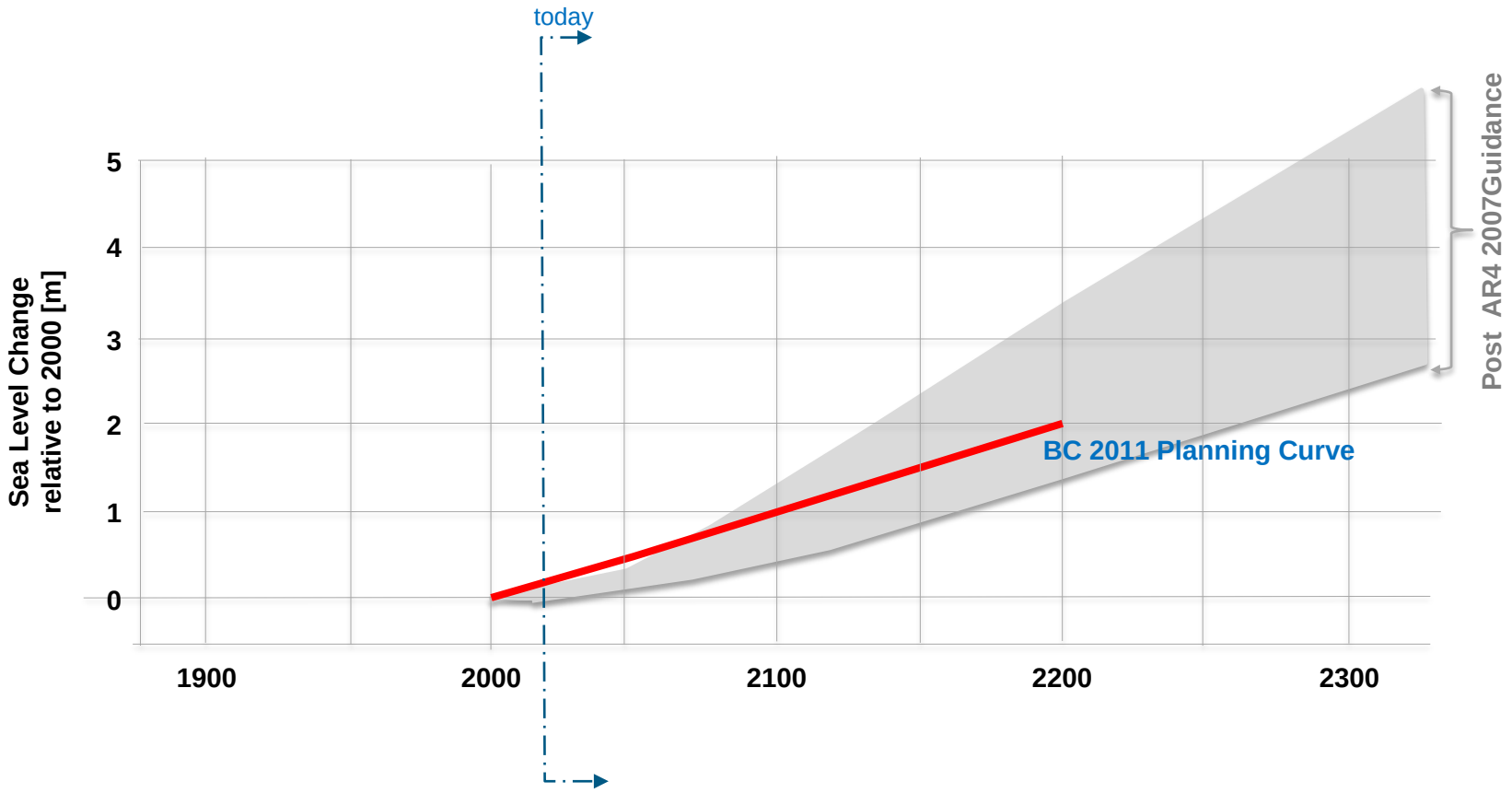
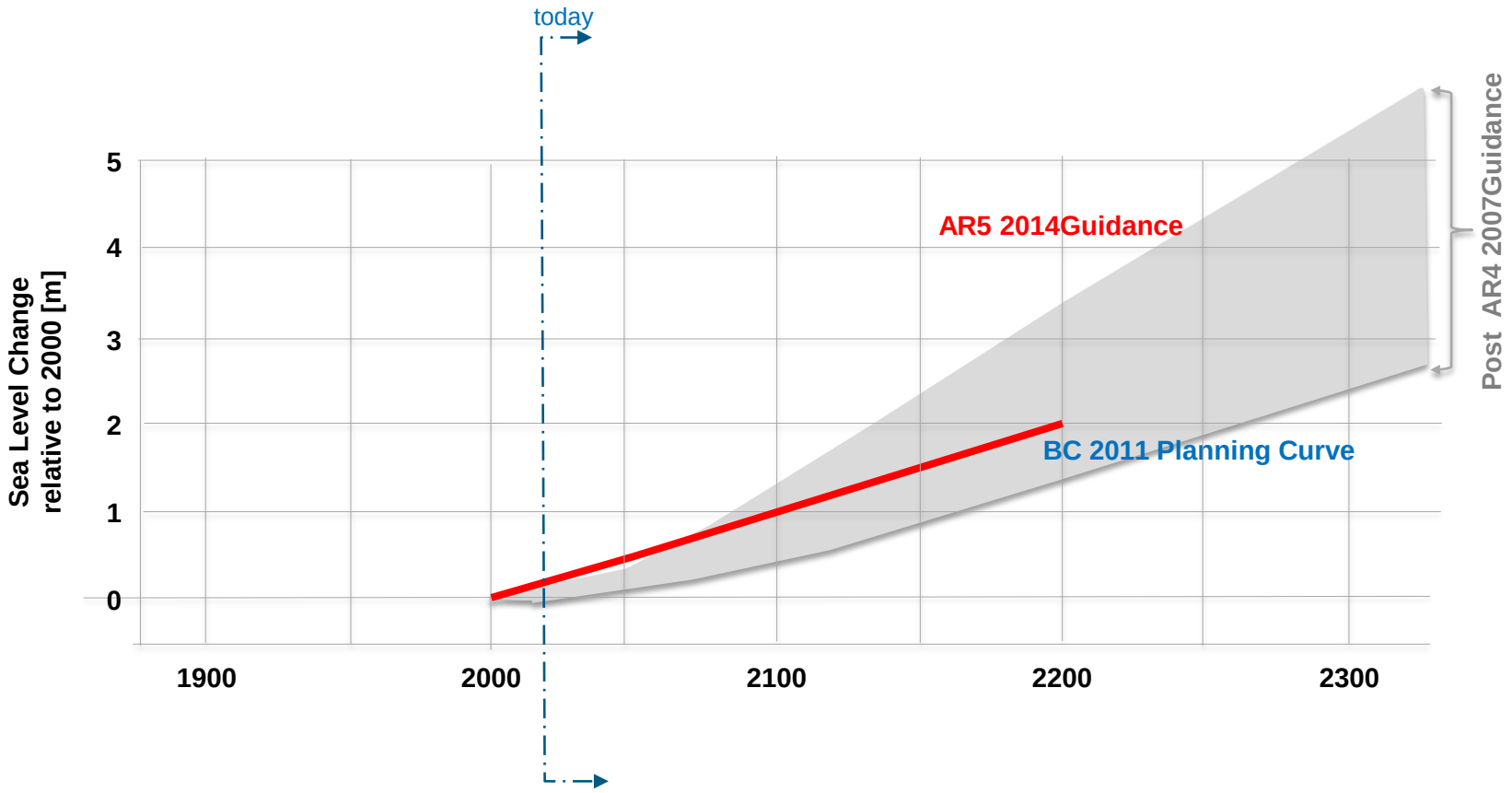
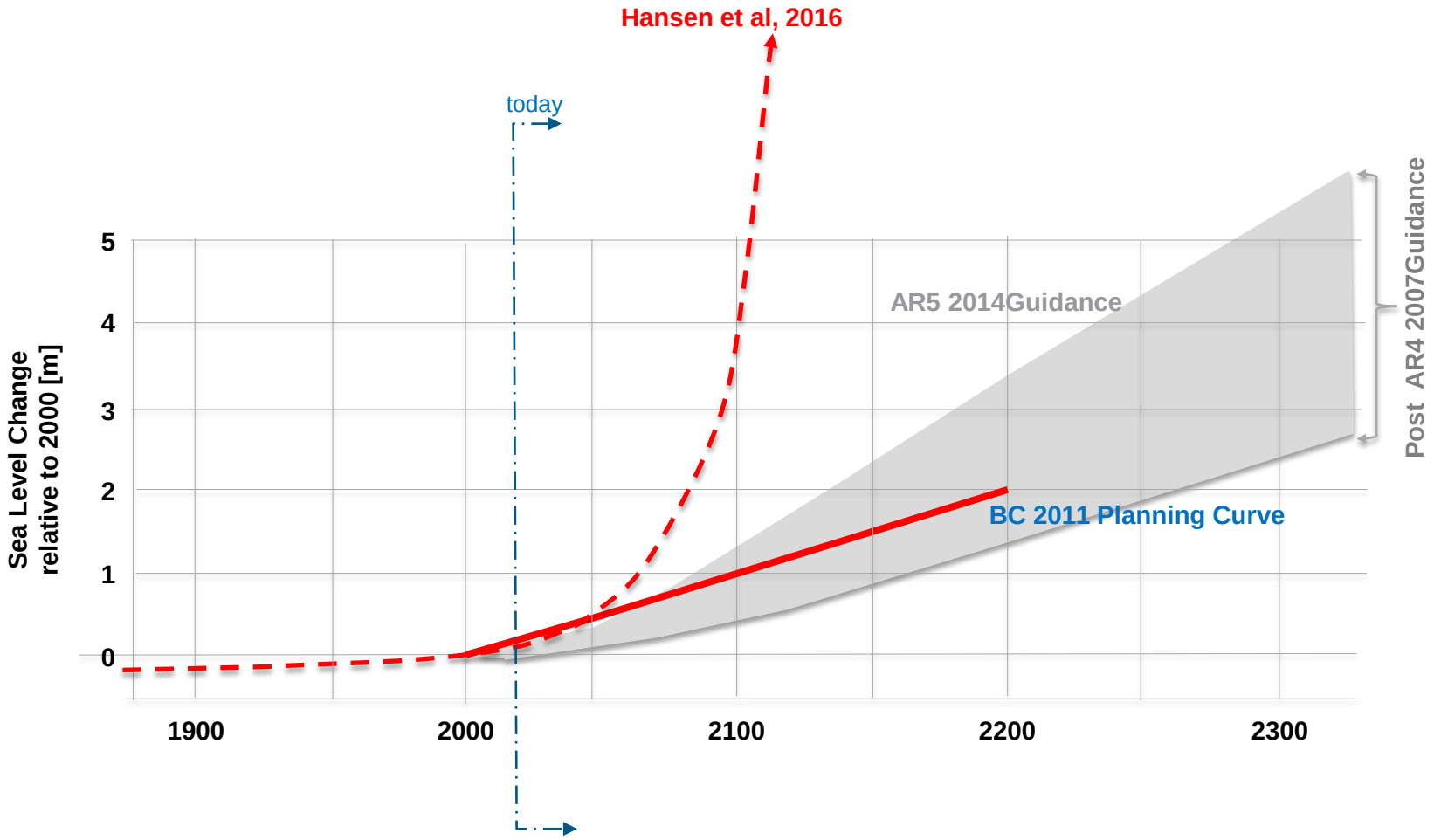
Sea Level Rise Guidance 2017



Sea Level Rise Guidance 2017



Sea Level Rise Guidance 2017



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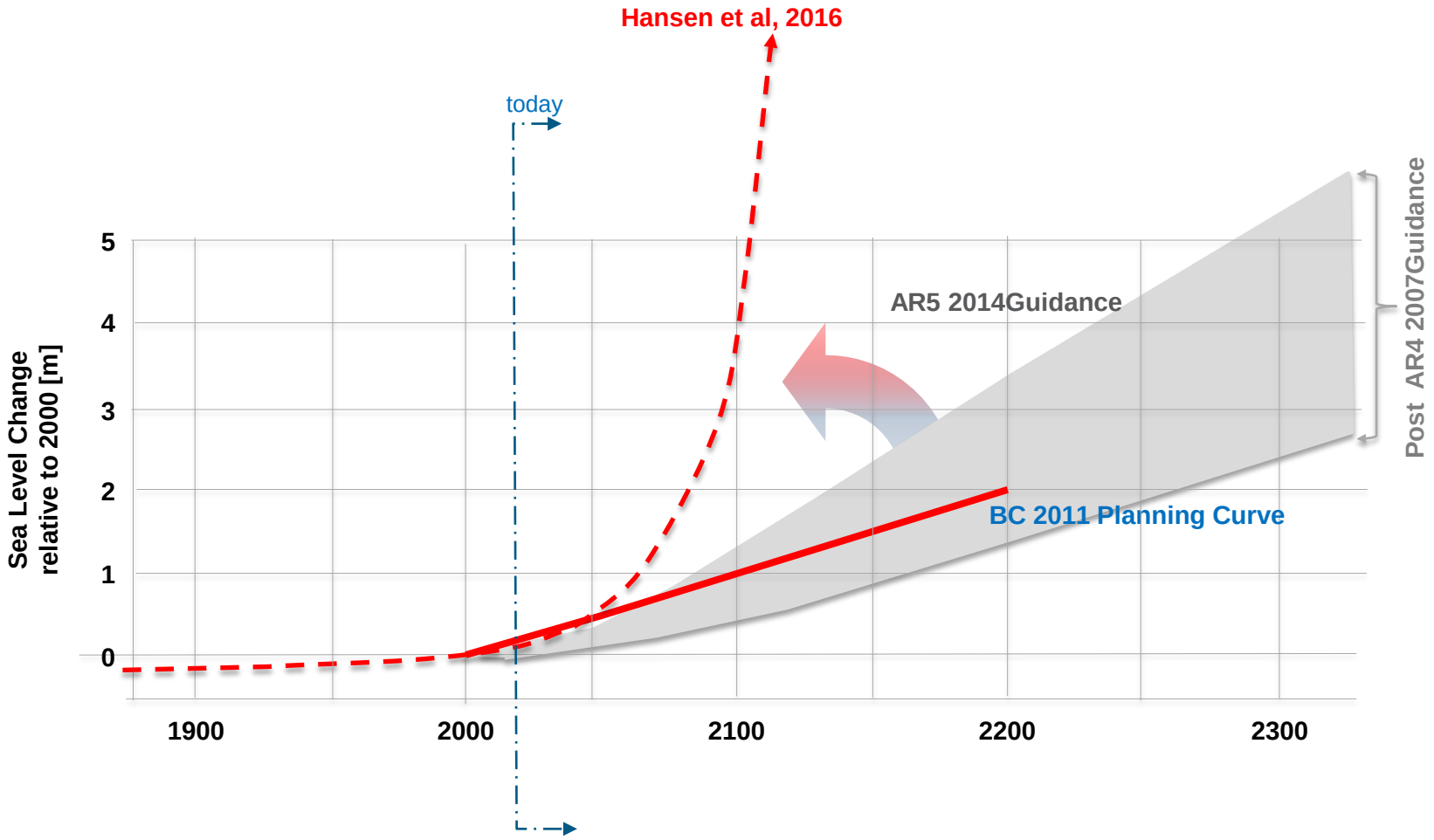

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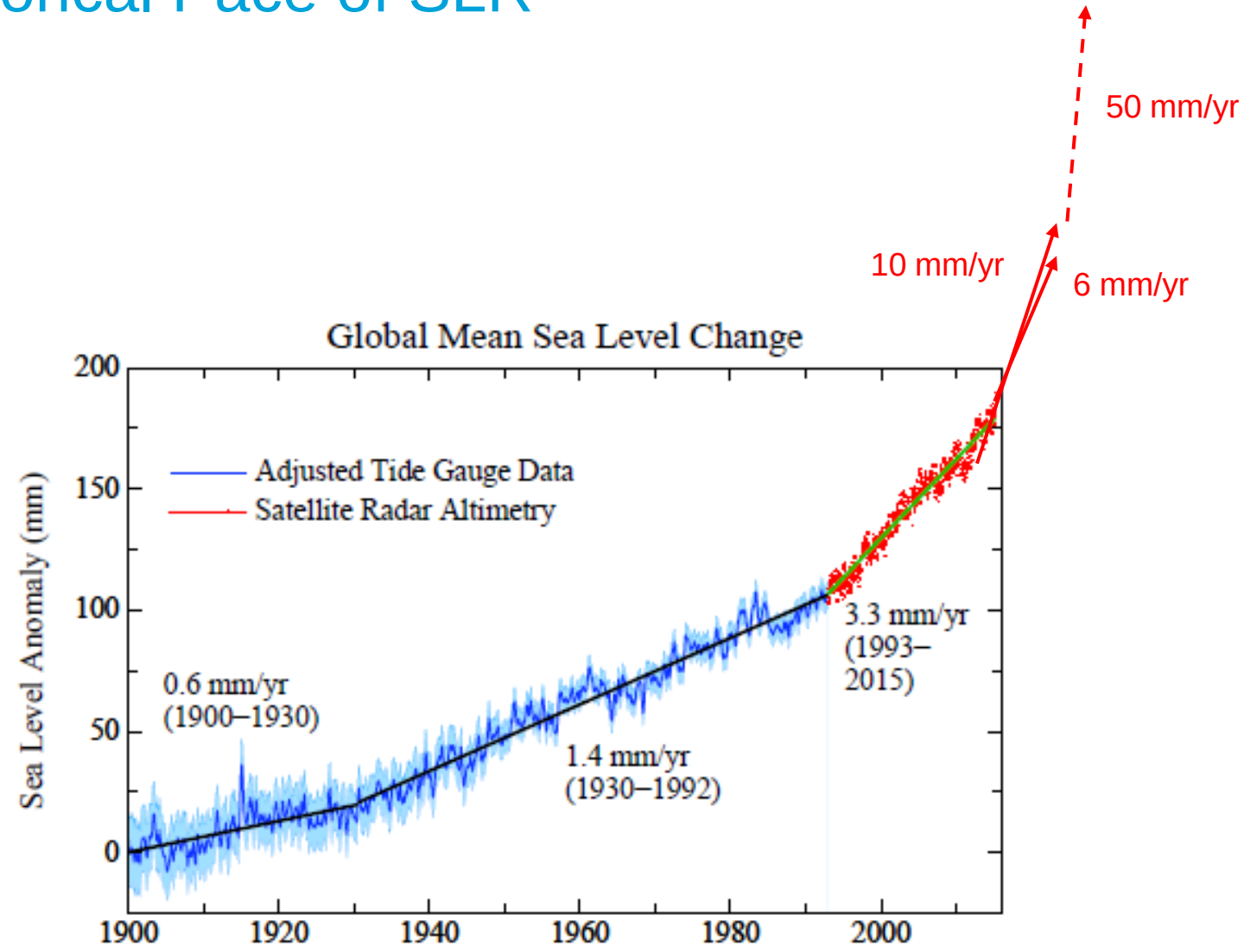

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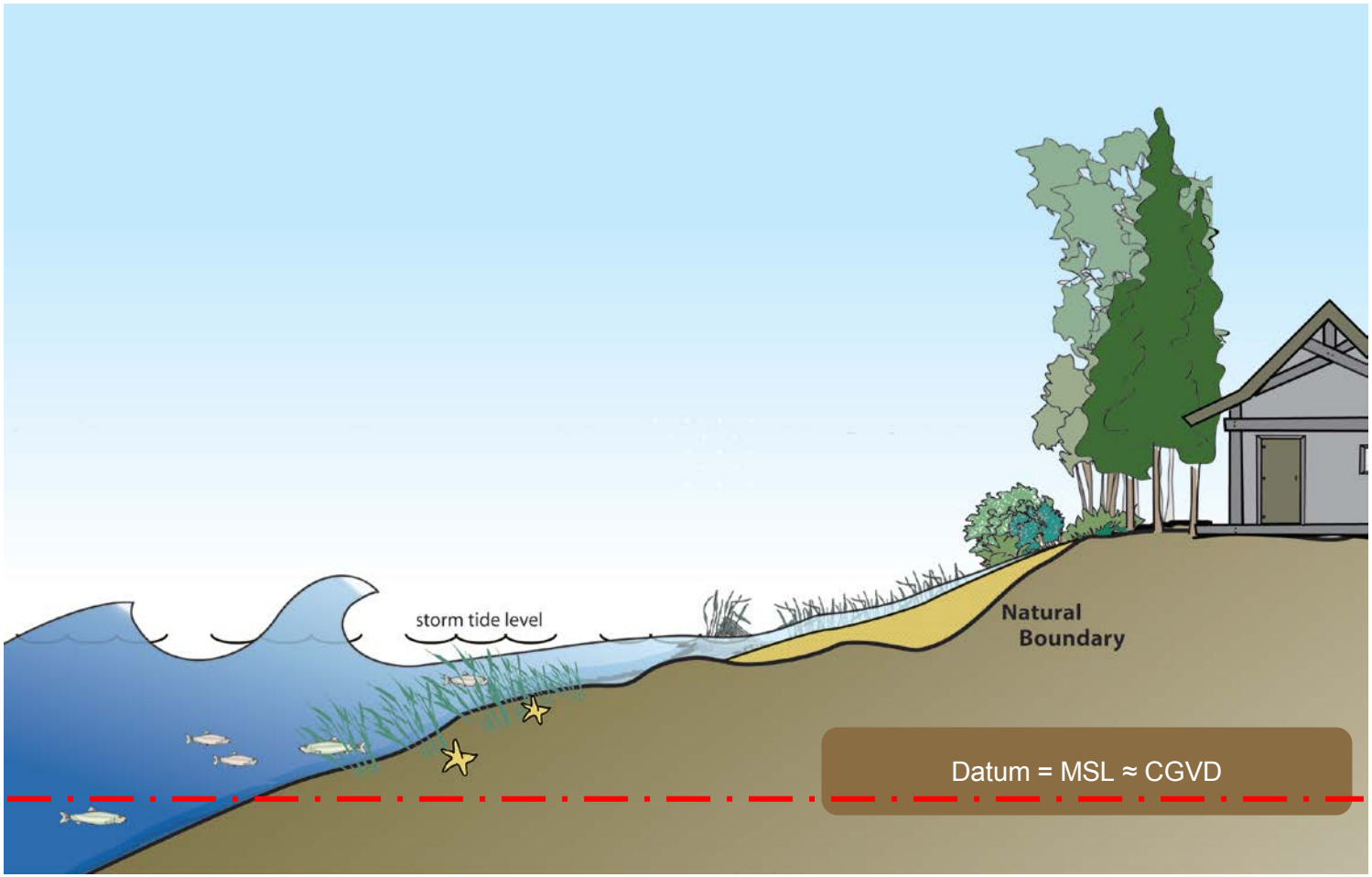
Implications

Implications to Shorelines



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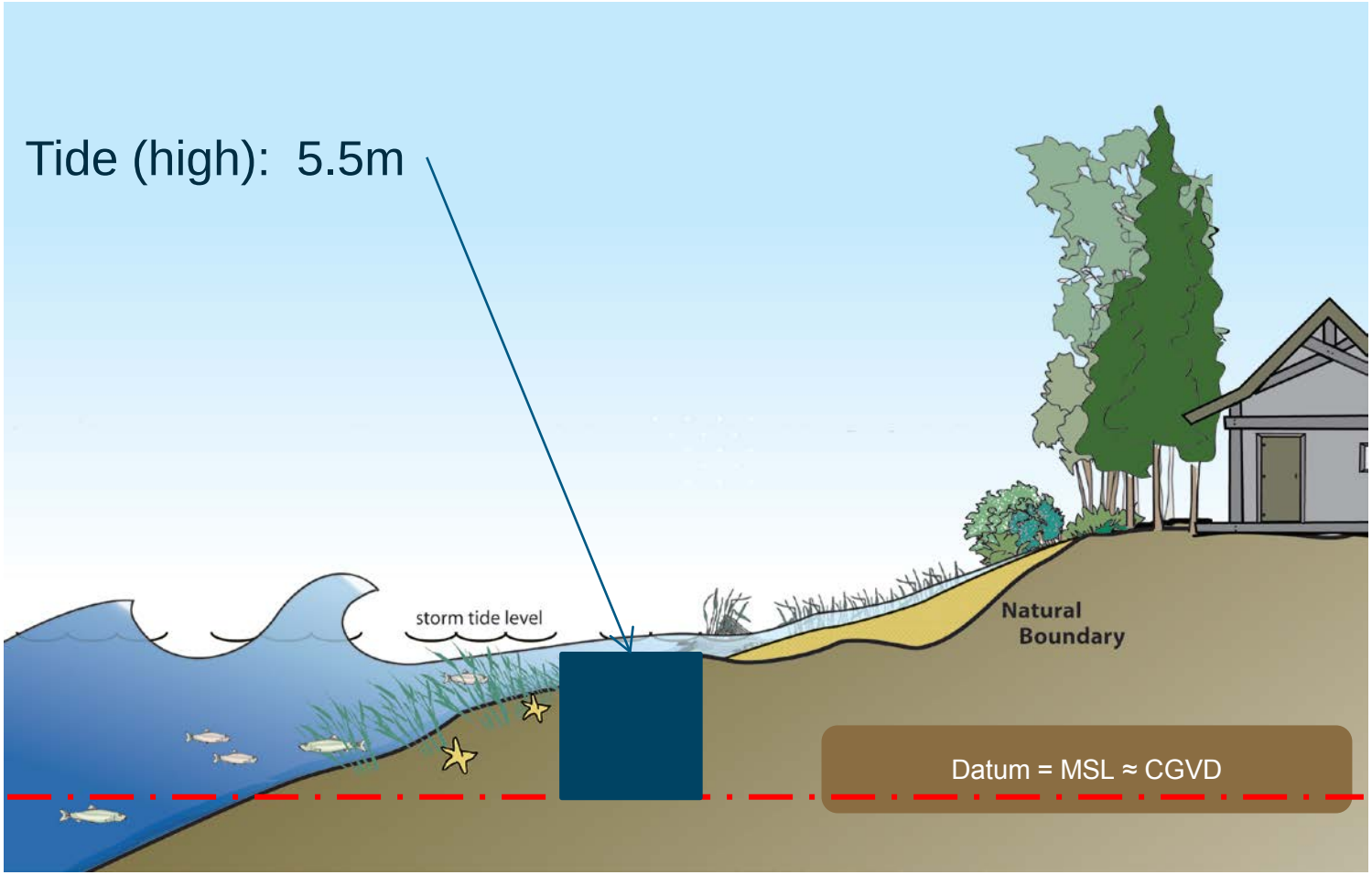

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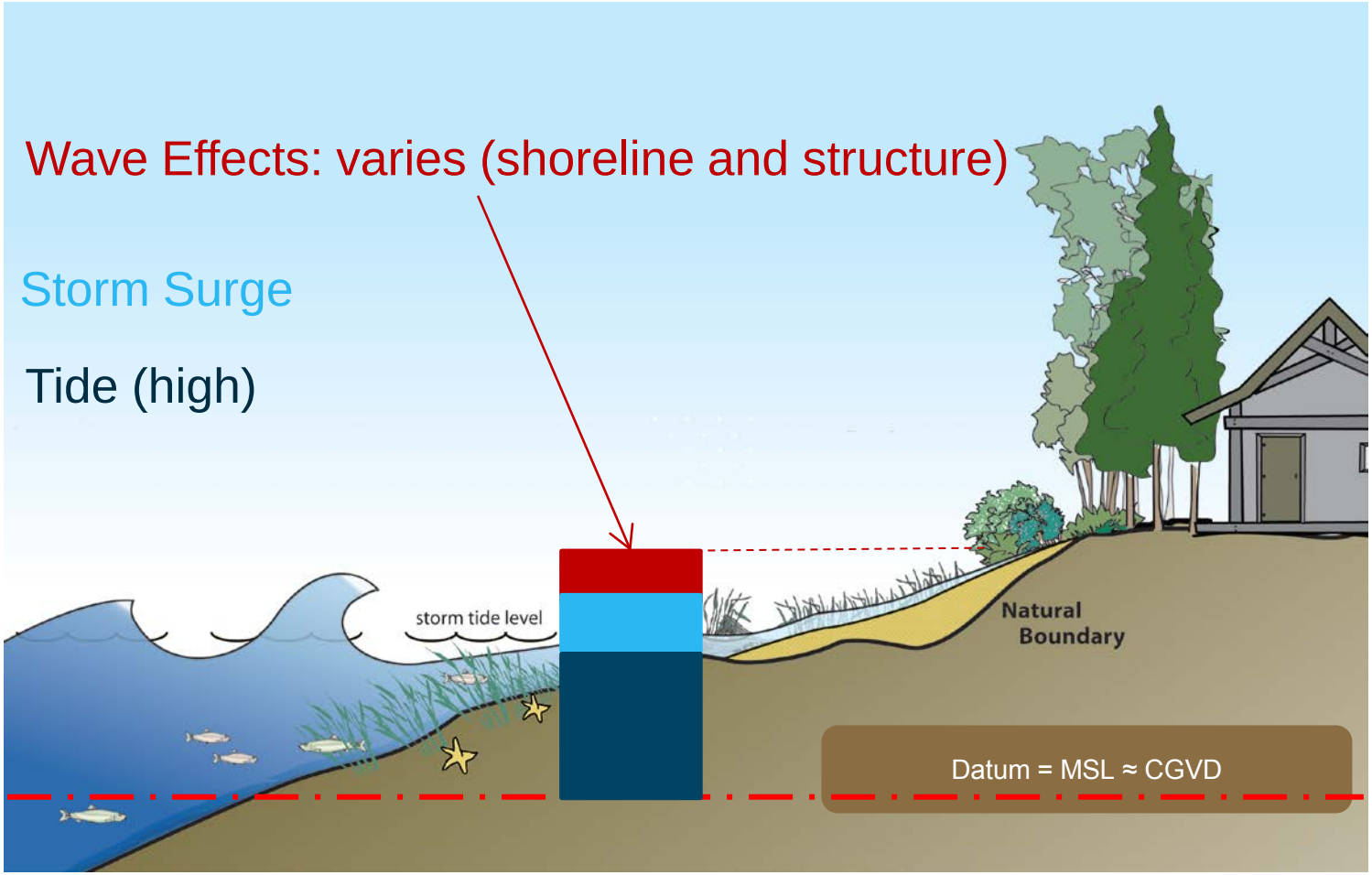

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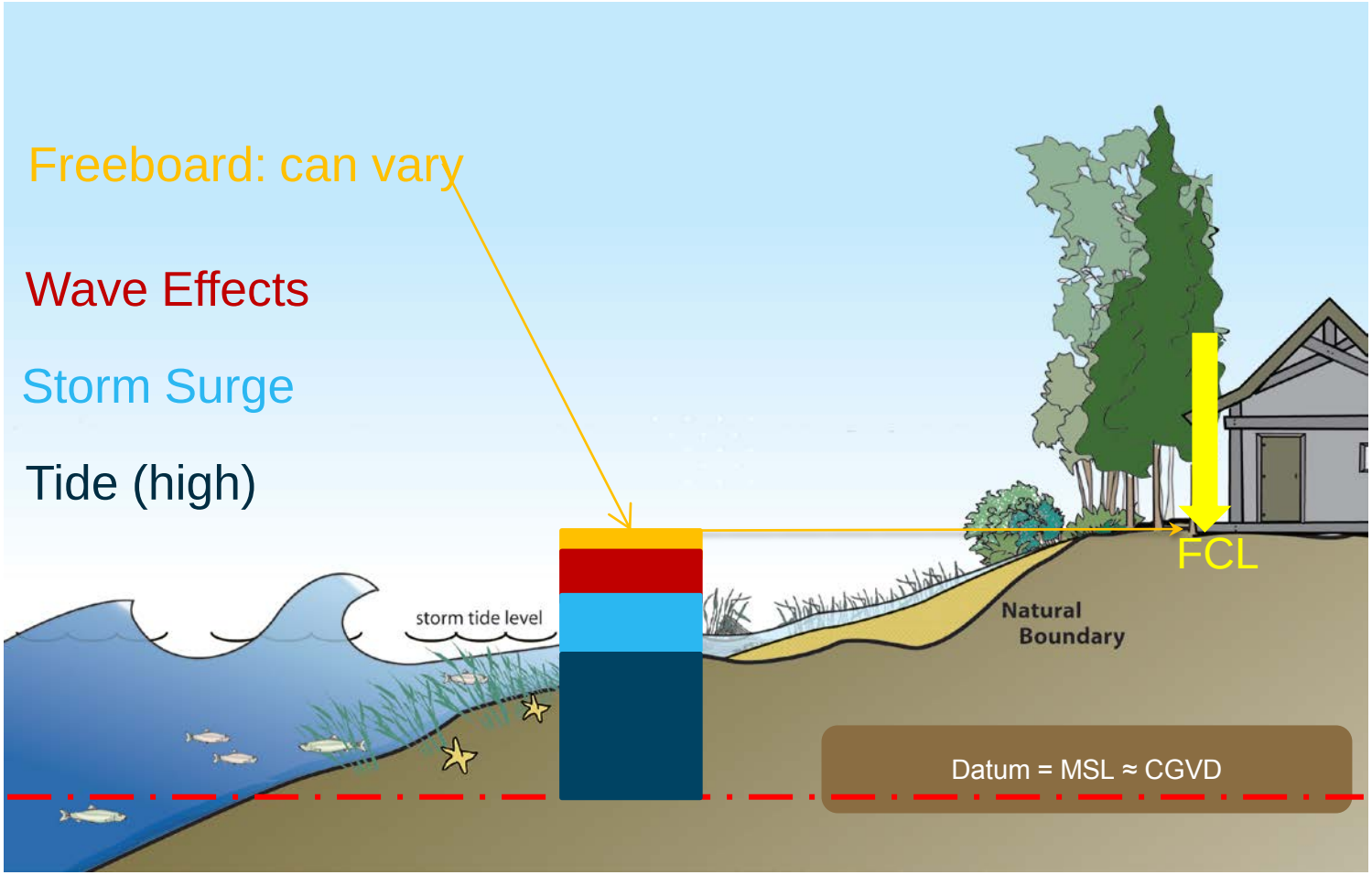

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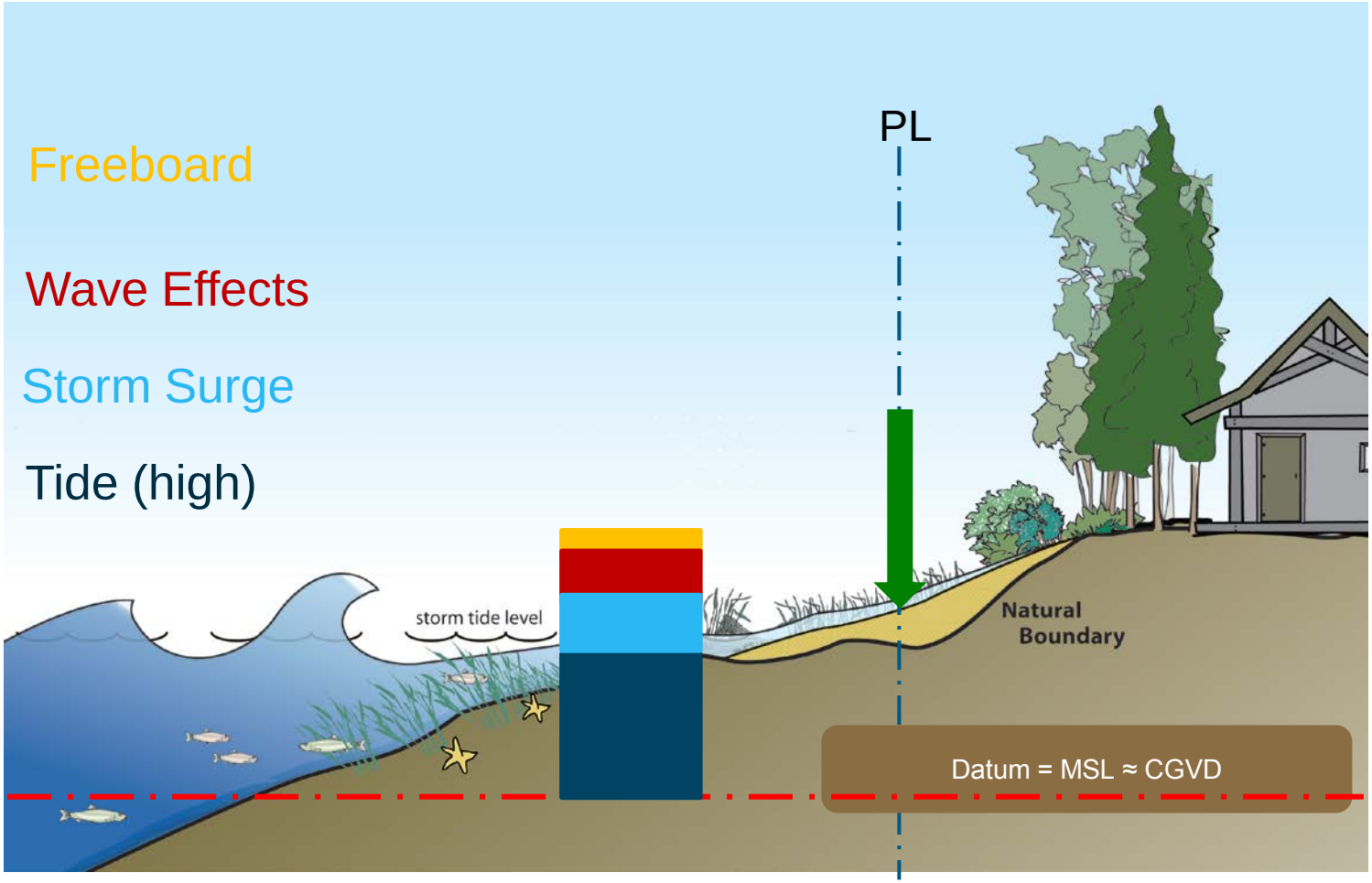

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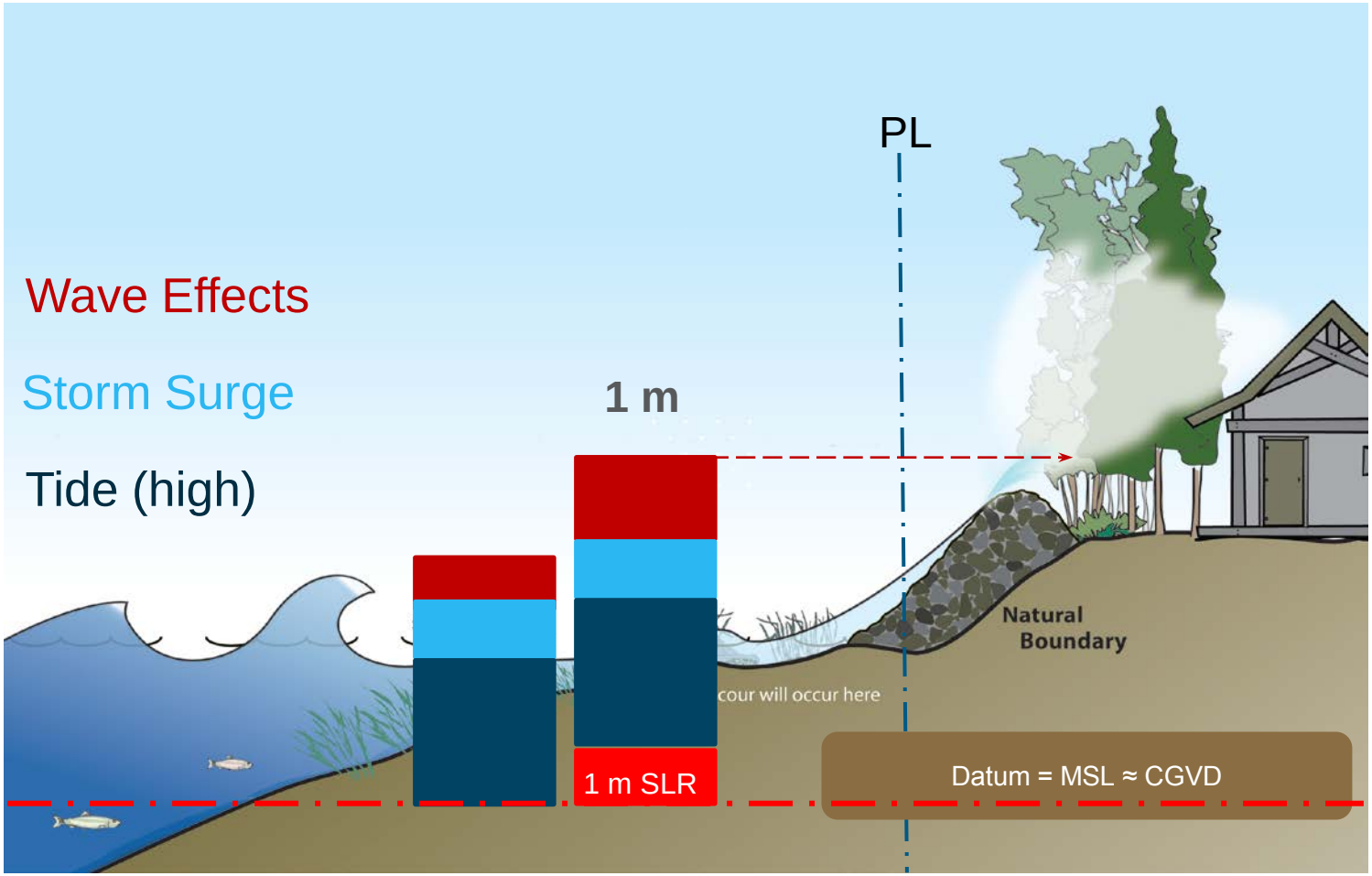

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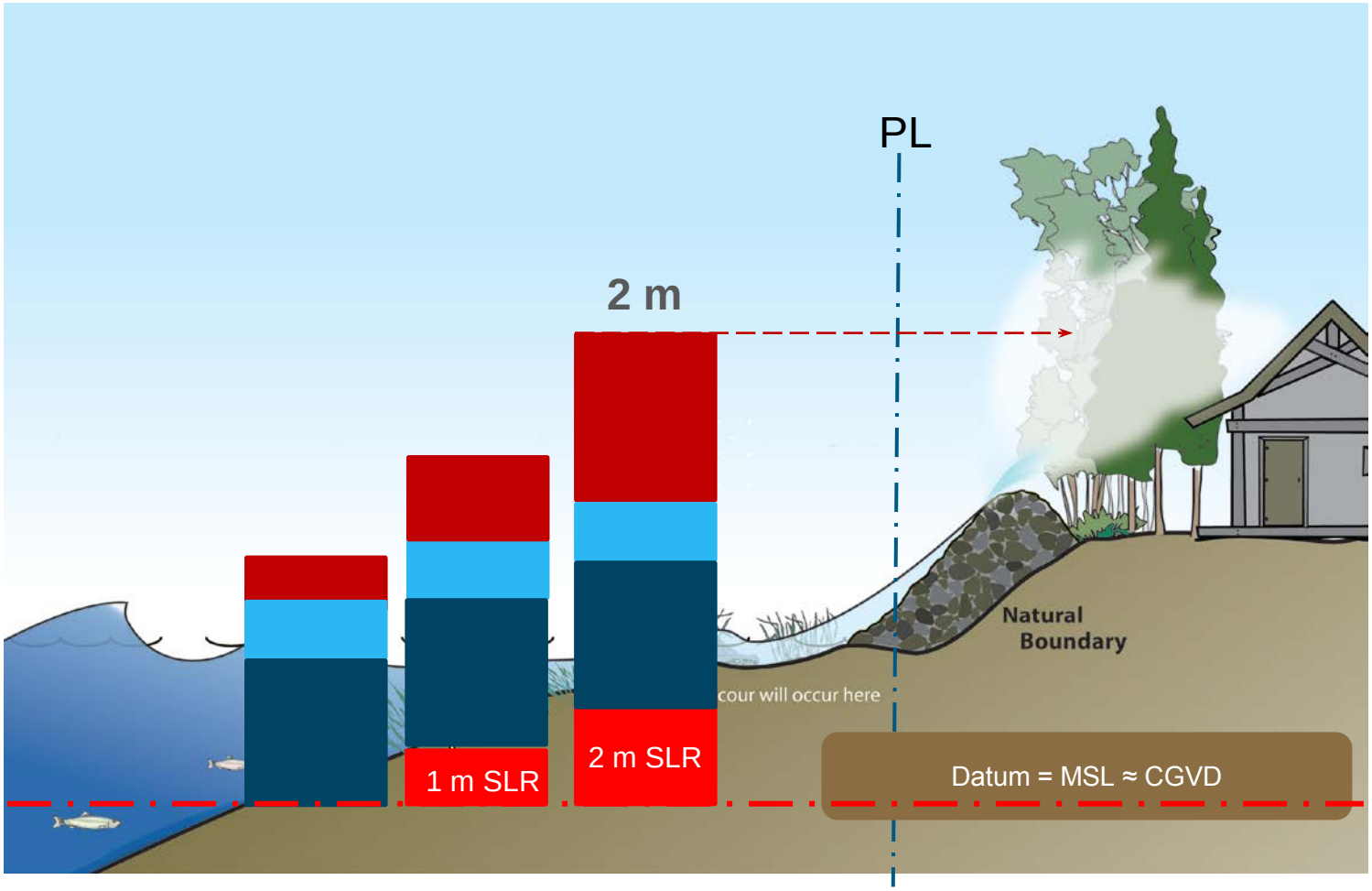

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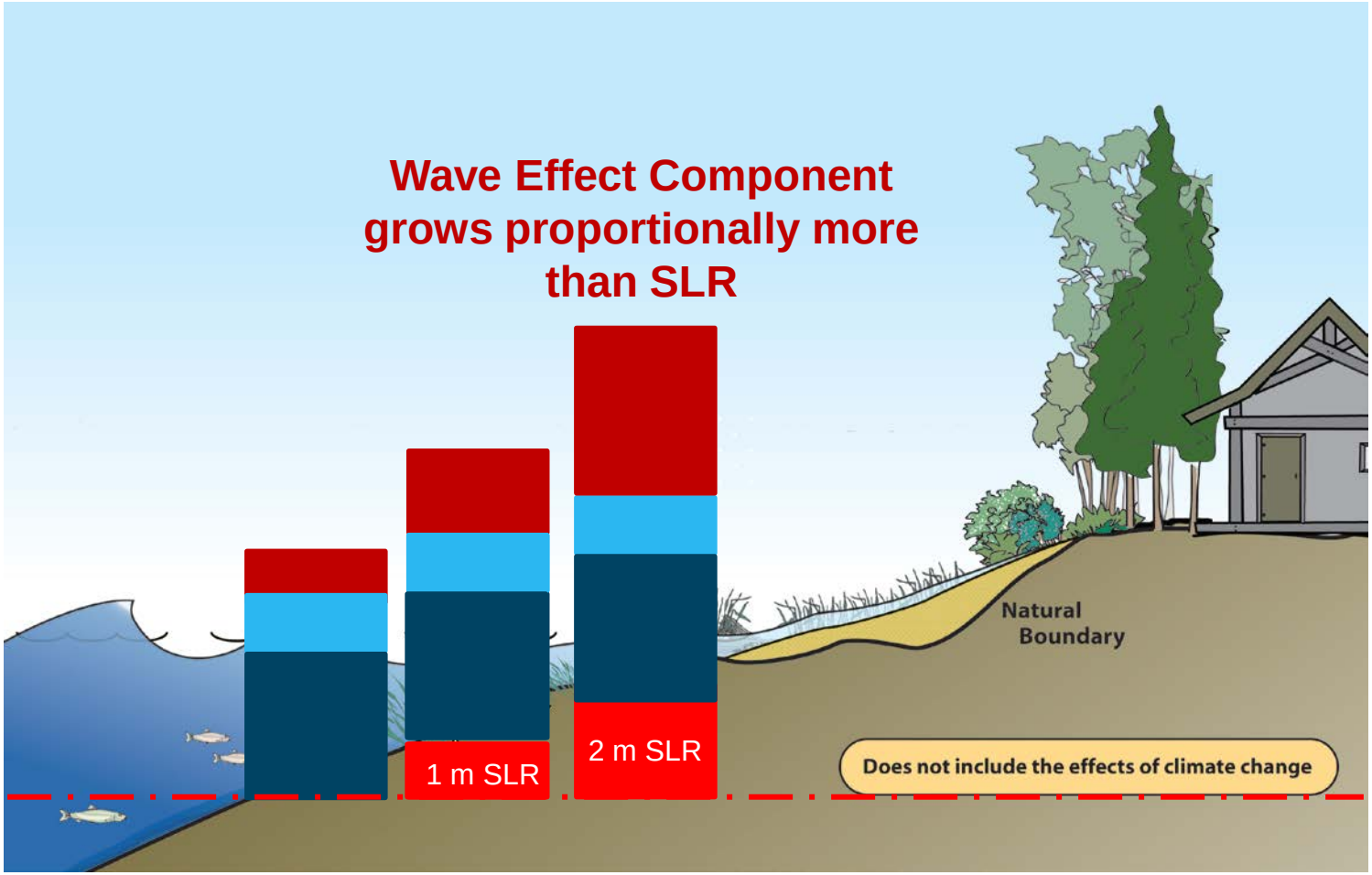

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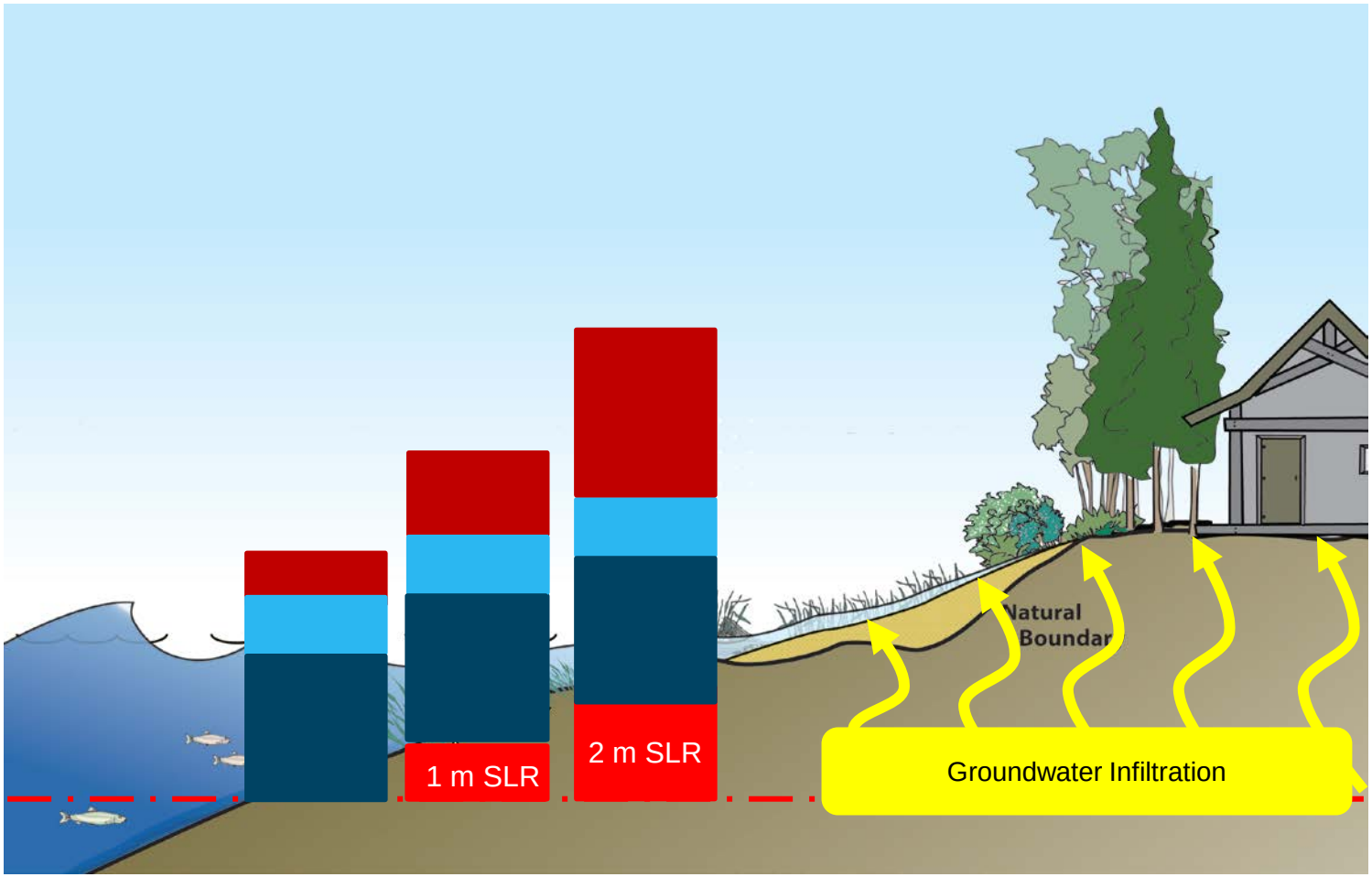
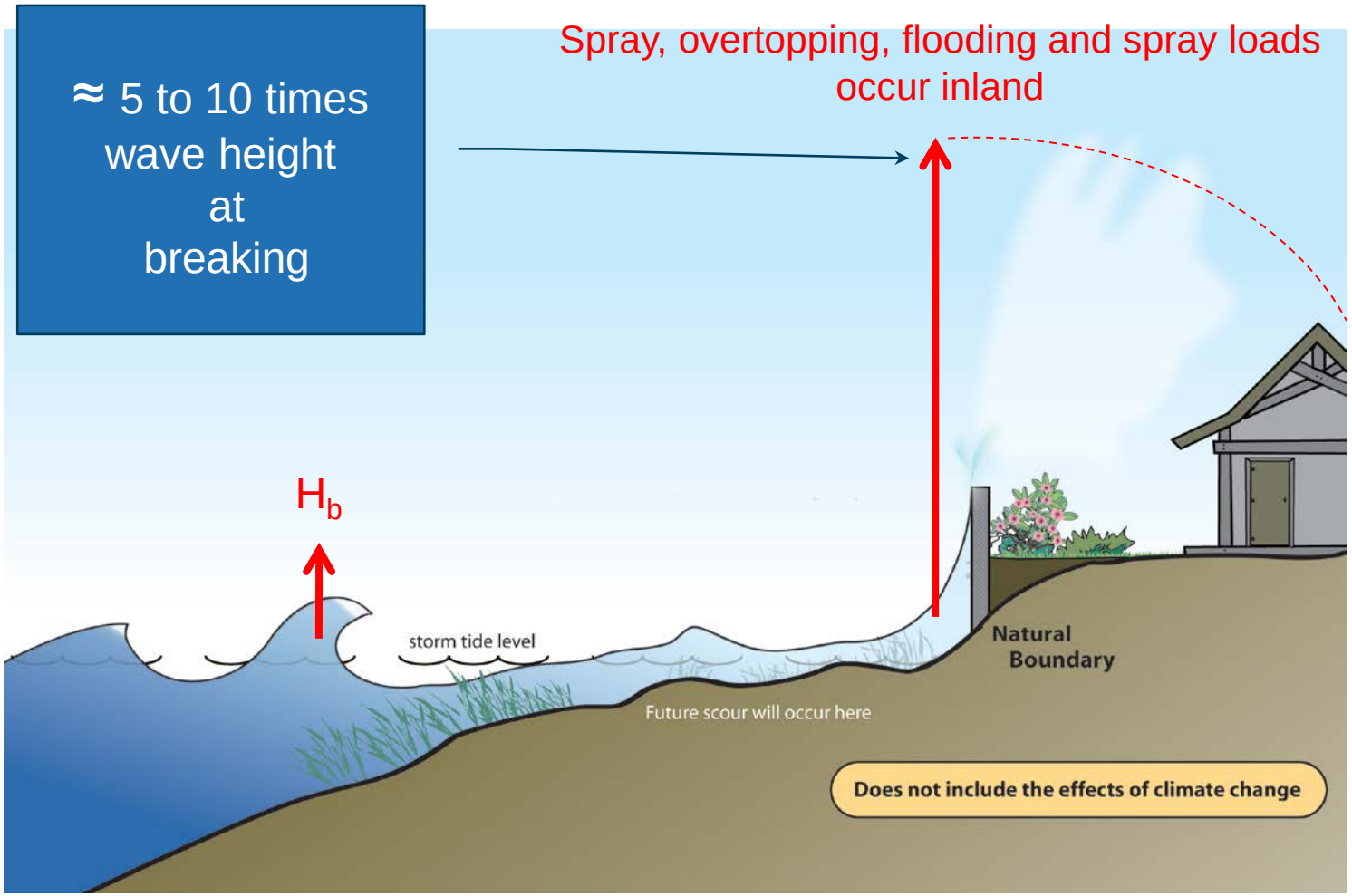
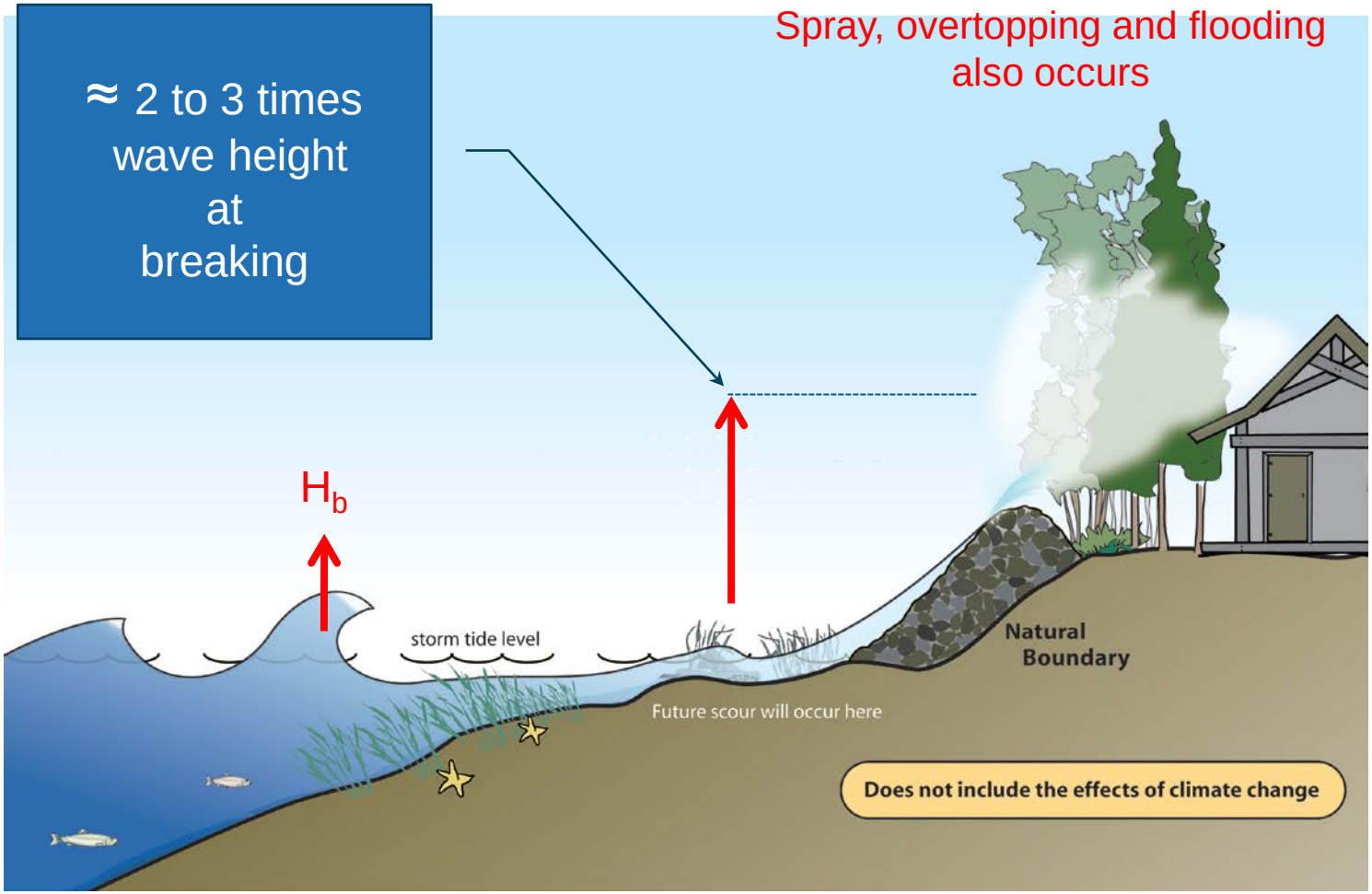


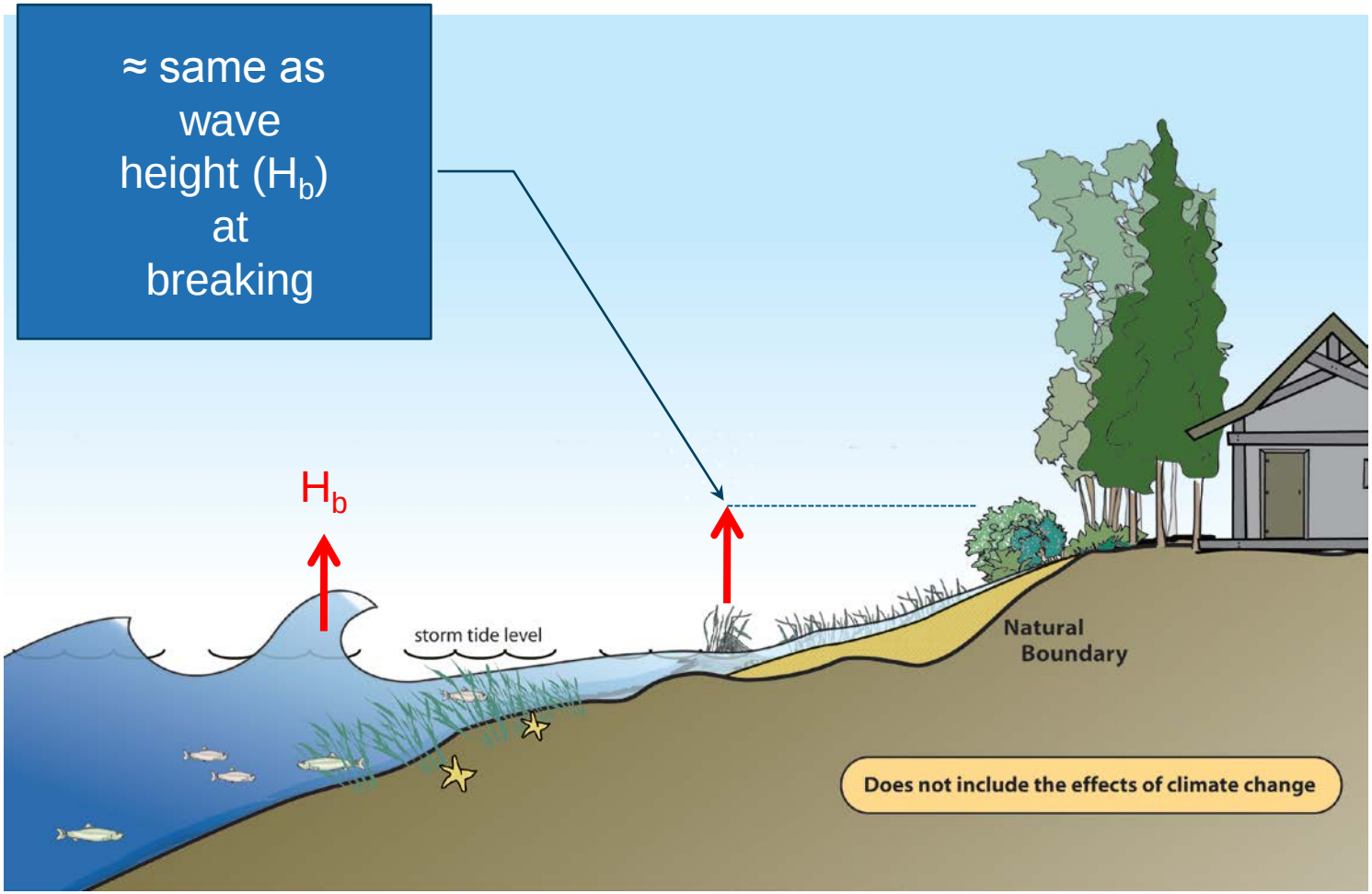
Wave Effect and Structures
Vertical Walls



Wave Effect and Structures
Steep Slopes - Revetments



Wave Effect and Structures
Gentle Slopes - Beaches



Eco-Assets

Low and Shallow Subtidal vegetation

Upper intertidal Marsh Areas

High Water and Supratidal Salt Marsh Areas

Eco Assets

Salt Marsh and Subtidal Eco Asset Cross Benefits

Eco Assets

Salt Marsh and Subtidal Eco Asset Cross Benefits

- Migratory bird habitat
-
-
-
-
-
-

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Salt Marsh and Subtidal Eco Asset Cross Benefits

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- Fisheries habitat
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Salt Marsh and Subtidal Eco Asset Cross Benefits

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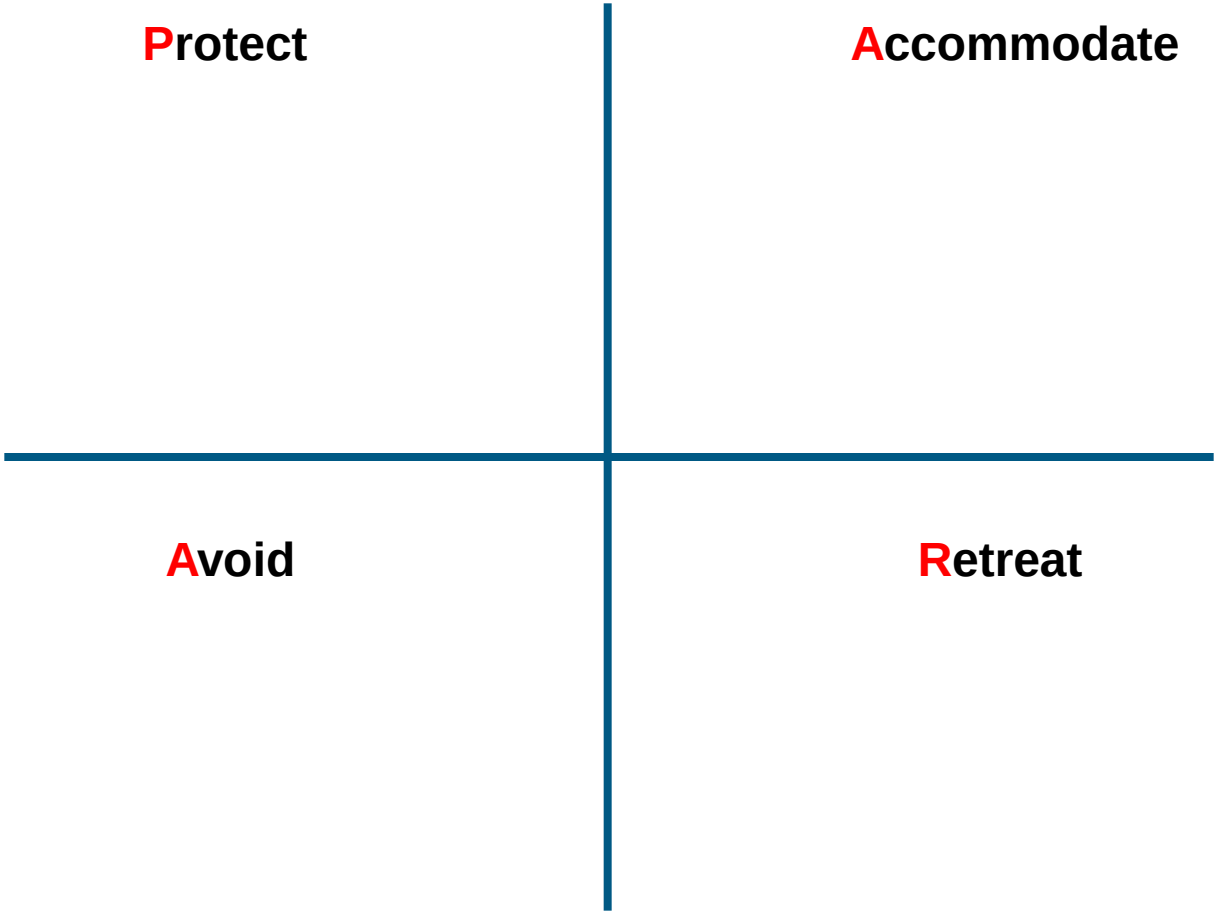
Options and Alternatives

Options for Adaptation



Protect

-Raise existing dikes
-Build more dikes
-**Build beaches**
-**Build marshes**

Accommodate

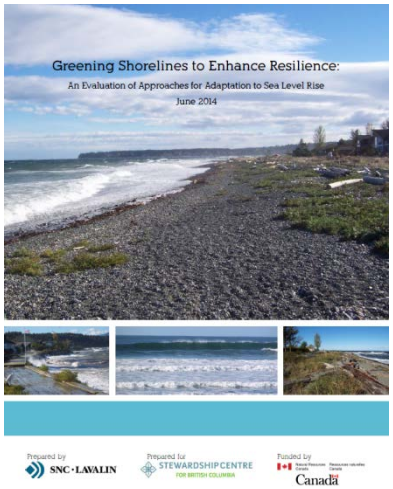
-Floodproof (raise) existing properties
-Wet or Dry Floodproofing
-Plan, Phase and Manage Re-Development

Avoid

PROBABLY NOT AN OPTION
EXCEPT AT RE-DEVELOPMENT

Retreat

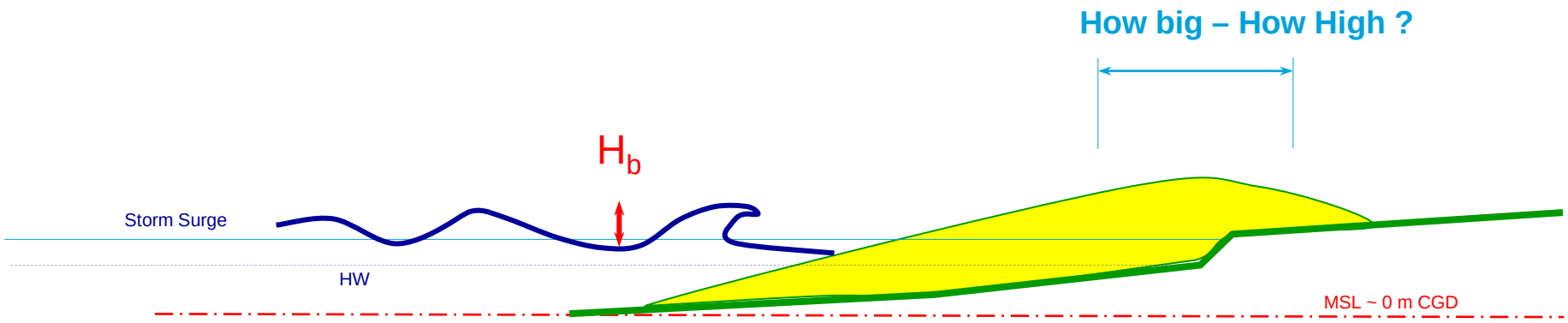
-Move to Higher Ground?
-Change or trade land usage
-Re-purpose lowest land areas



Cost Effectiveness

Case Example		Hard Alternative	Soft Alternative	Comment
1	Qualicum Beach	$33,000/m	$10,000 - $14,000/m	Depending on choice of sand or gravel/pebble/cobble.
2	Marr Creek Inter-tidal	$35,000/m	$25,000/m	Assumes cost basis presented above. Does not include cost of maintaining dry high tide access on existing walkway. Does not include the sunk costs of existing rock features already on site.
3	Private Property	$8000/m	$4000/m	Does not include sunk cost of existing headland beach system

Beach Options



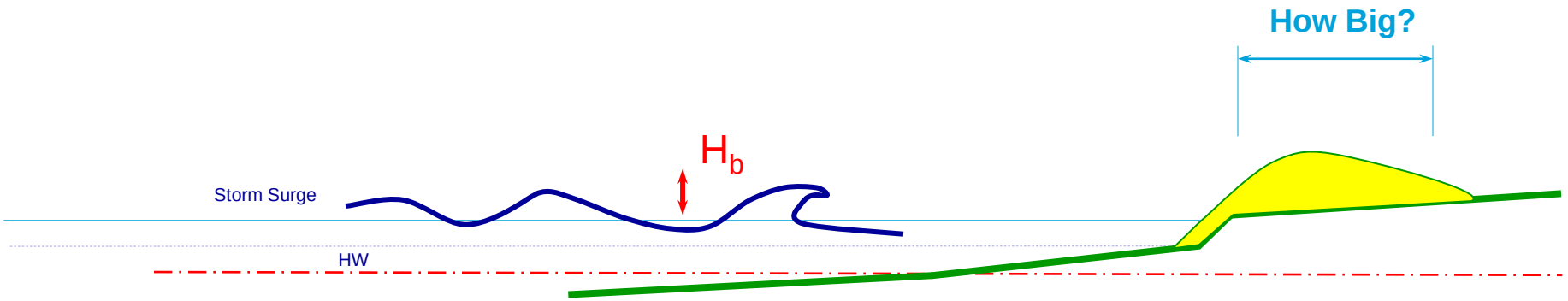
Ross Bay – Victoria

Replacement of Recurved Seawall with Stepped Seawall

led to structural damage in buildings visible in background

Performance

Beach Options – Storm Berm (Dune)



Storm Berm Example- Victoria

Storm Berm Example- Balboa Penisula CA

Living Shoreline Options

Living Shorelines

- New Jersey
- Delaware
- Maryland
- Virginia


Credit: Living Shorelines Engineering Guidelines – Planted Dike


Credit: Living Shorelines Engineering Guidelines – Marsh Sill


Credit: Living Shorelines Engineering Guidelines – Oyster Reef

Living Shoreline Options

Living Shorelines

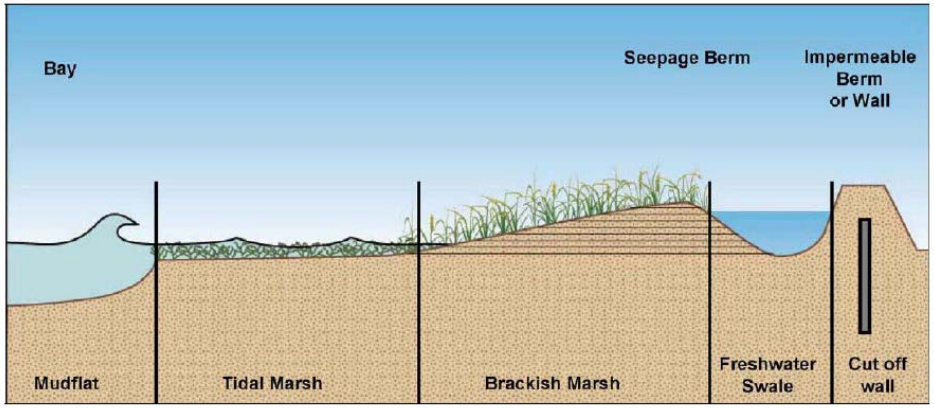
- New Jersey
- Delaware
- Maryland
- Virginia

Horizontal Dikes

- California (San Francisco Bay)
- Louisiana Marshlands Restoration projects

Netherlands

- Zuider Zee Dike/Autoroute Crossing
- “Sand Engine”



Credit: ESA PWA 2013

Credit: Delta Committee

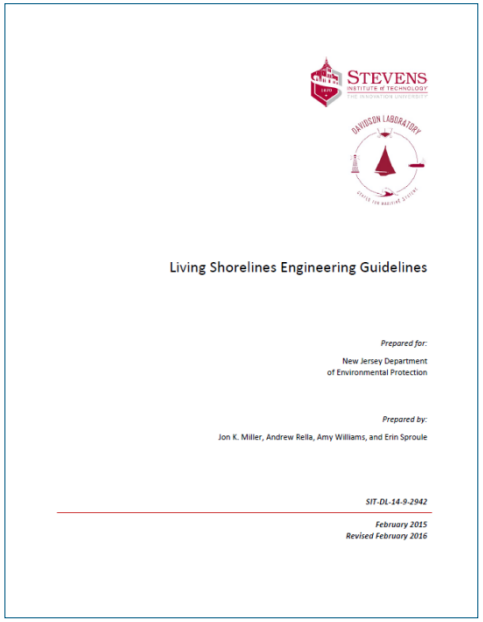
Living Dike Concept

What is a Living Dike?

Living (Oyster) Reefs are referenced in:

Living Shorelines Engineering Guidelines (NJ DOE 2016)

Credit: Living Shorelines Engineering Guidelines (2016)



STEVENS INSTITUTE OF TECHNOLOGY

DAVIDSON LABORATORY

Living Shorelines Engineering Guidelines

Prepared for:

New Jersey Department of Environmental Protection

Prepared by:

Jon K. Miller, Andrew Rella, Amy Williams, and Erin Sproule

SIT-DL-14-9-2942

February 2015
Revised February 2016

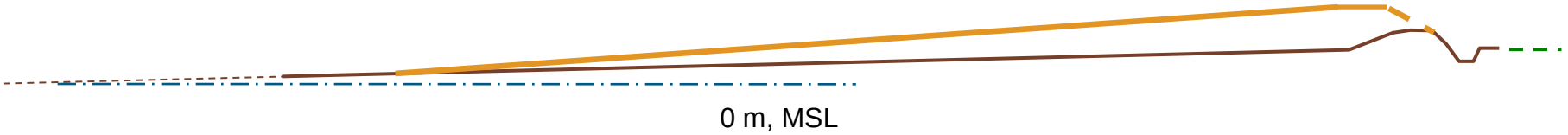
What is a Living Dike?

Provides the required degree of protection for safety of personnel and property for Coastal Flood Hazard Lands

Provides or maintains a predefined Ecological Function

Credit: Living Shorelines Engineering Guidelines (2016)

Living Dike – Structure – 1 m SLR



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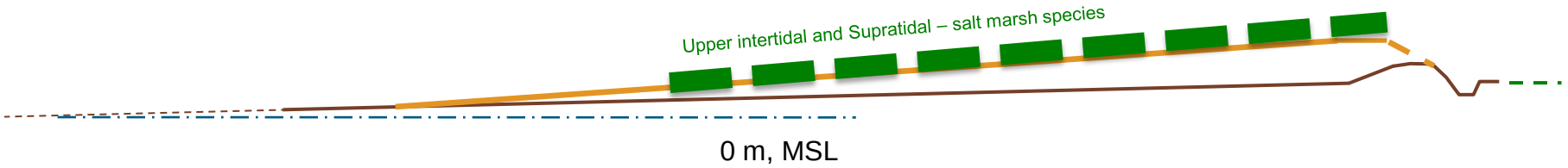

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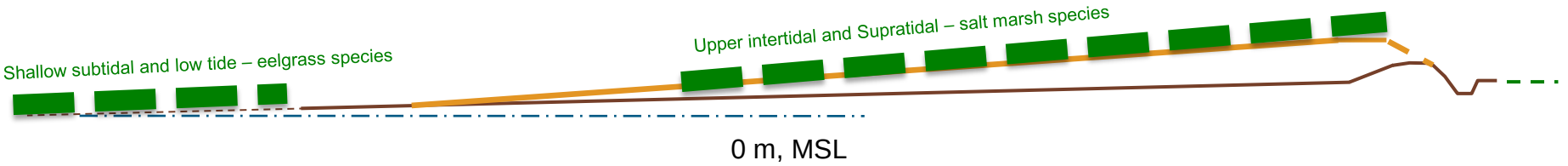
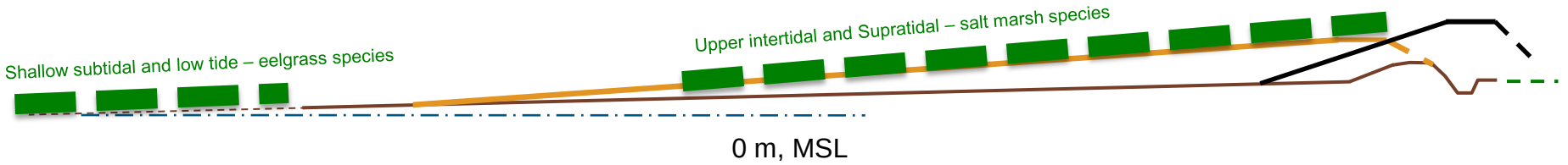


Standard Dike - Living Dike – 1 m SLR



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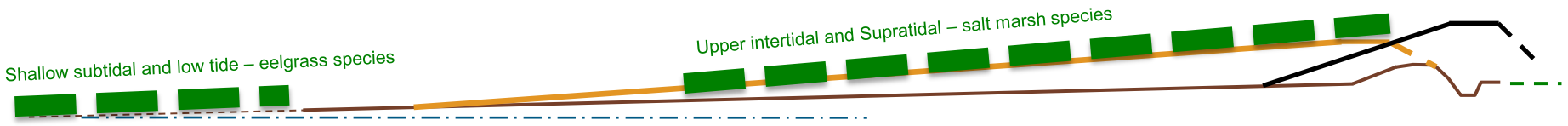
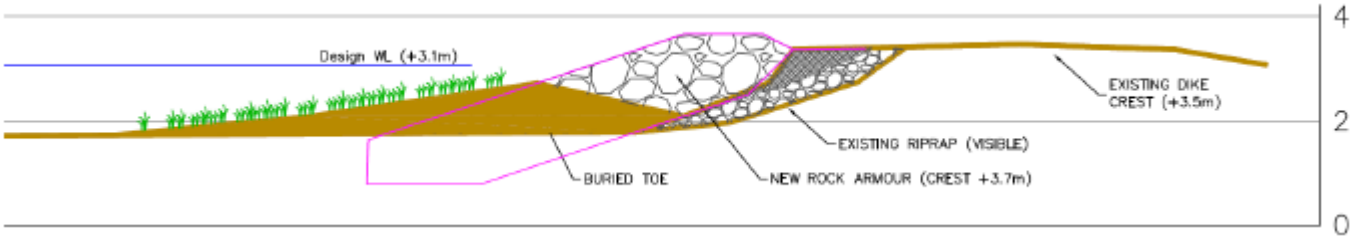


0 m, MSL



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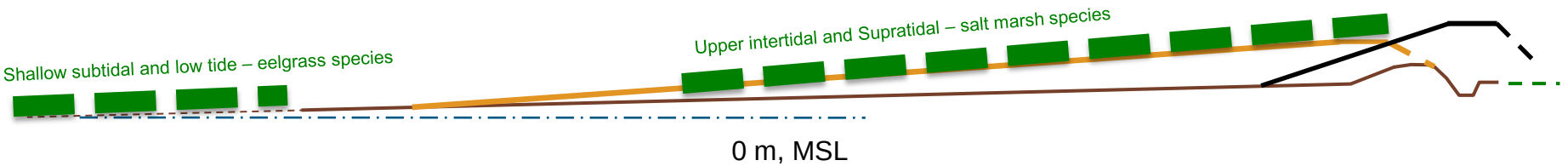


Table 1 – Summary of SWASH overtopping rates (mean and maximum discharges)

Case	Description	Overtopping Rate (litres/s/m)	
		Mean	Max
1	Pre-existing Dike	42	276
2	Pre-existing Dike with Offshore Salt Marsh Enhancement	17	159
3	Dike Upgrade with Buried Toe	8	170
4	Dike Upgrade with Buried Toe and raised foreshore	9	229
5	Dike Upgrade with raised foreshore & Salt Marsh	3	86

How to Implement

Material Source

Fine Sand

Imported Source

- Tidewater quarry (Sechelt)
- Dredged Material from Fraser River

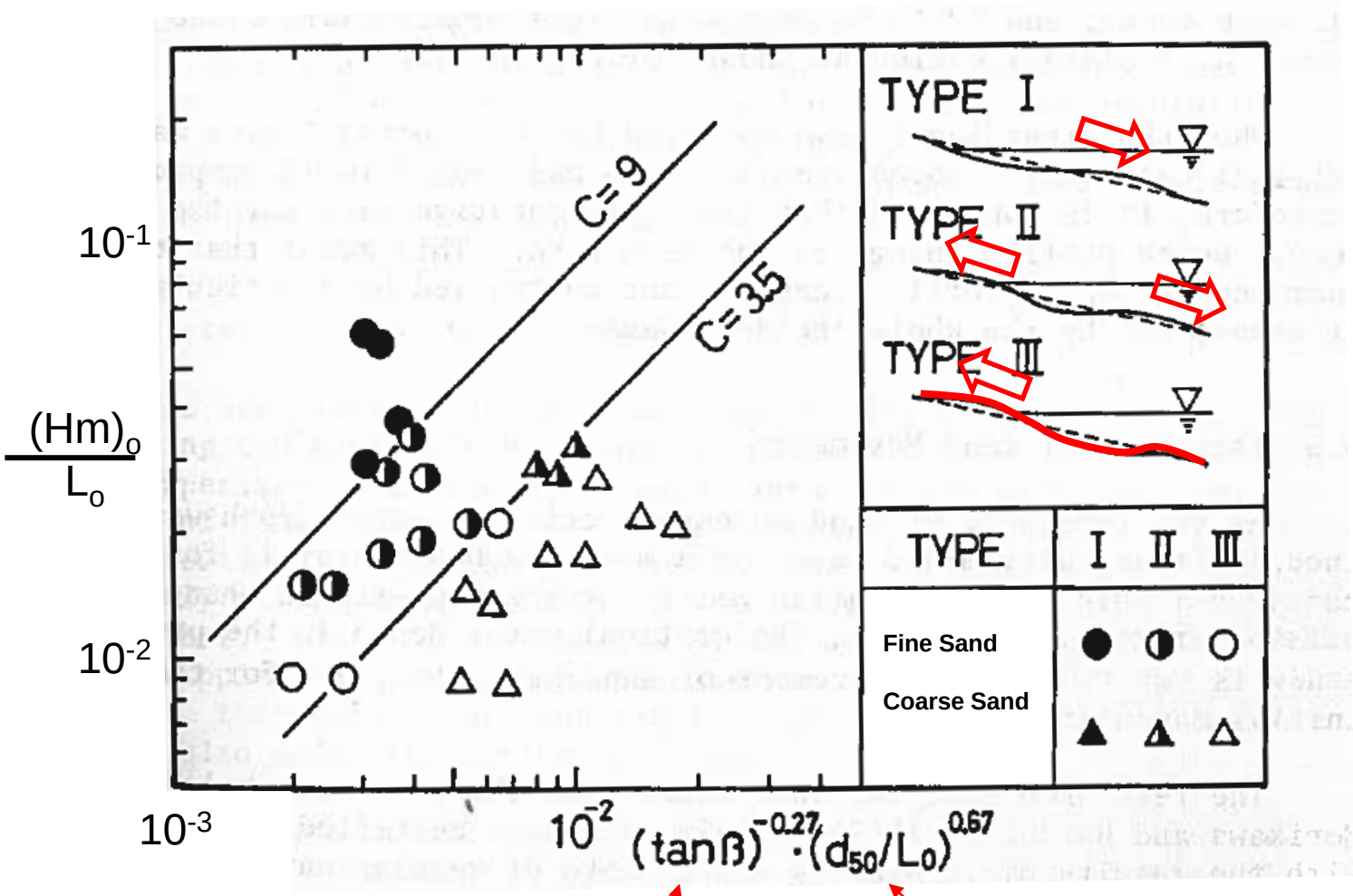
Potential Supply

- 2 – 3 million m^3/yr (Fraser River - sand)

Approximate Required Volume

- For 14 km of Living Dike:
- ≈ 2 – 3 million m^3 (design volume)

Basis for Wave Driven Onshore Transport

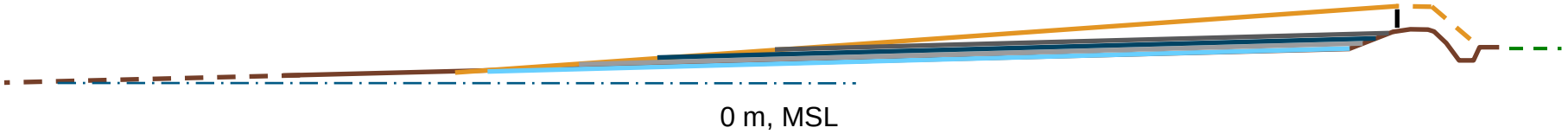


Mimura et al 1986

slope

sediment size

10 cm lifts on a 1:50 slope



Likely Transport and Placement methods

Truck Haul

- Very disruptive
- 300,000 truck loads
- Multiple handling at source, transfer and onto beach

Barge

Difficult to get close to shore

Multiple handling at source, transfer point and onto beach

Trailing Suction Hopper Dredge

Source in the Fraser River

Short sail to Boundary Bay

Ability to transfer to shore by several methods

Bottom dump

Pump to shore (2 km ±) without booster stations (problematic)

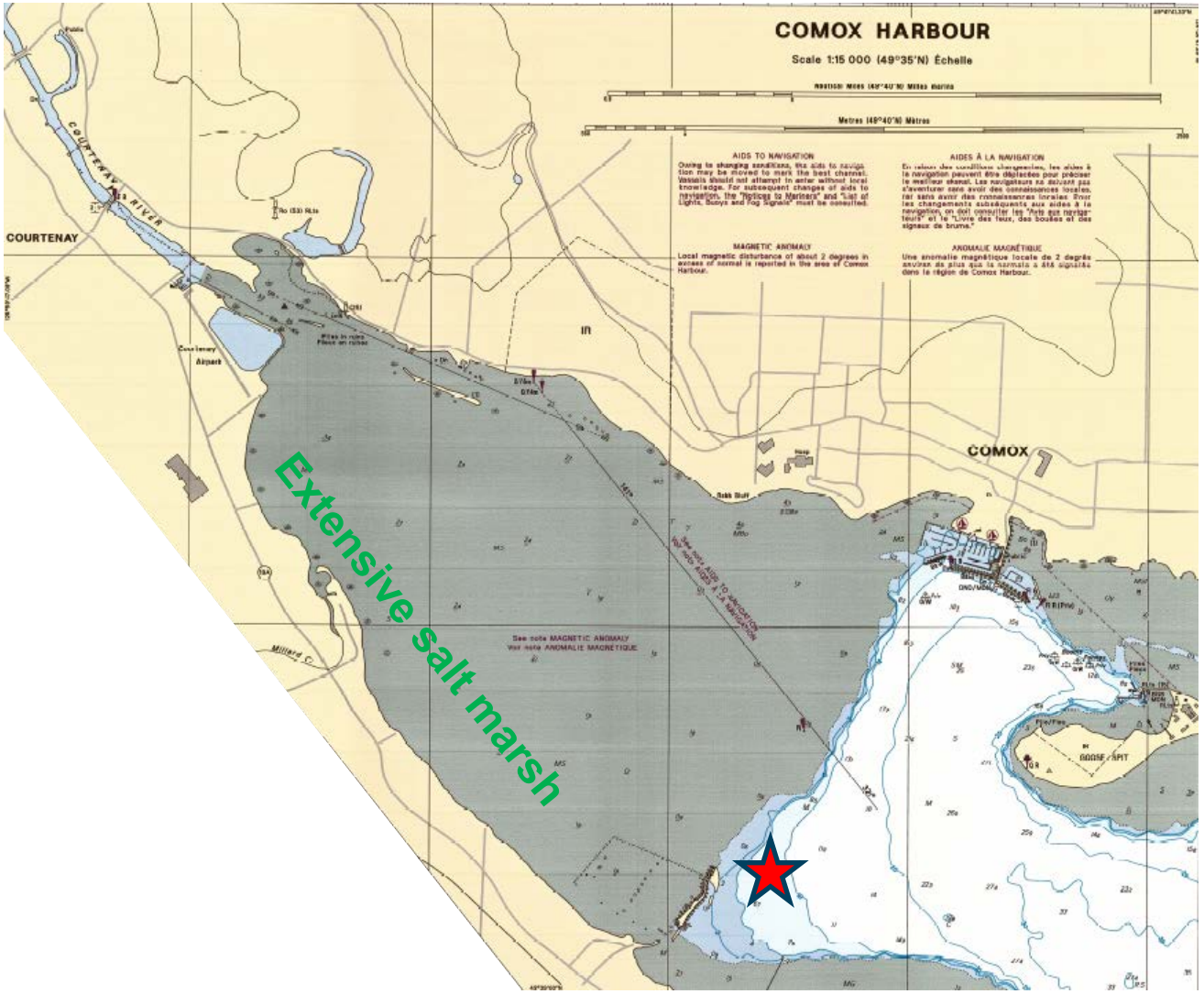
Rainbow

Trailing Suction Hopper Dredge

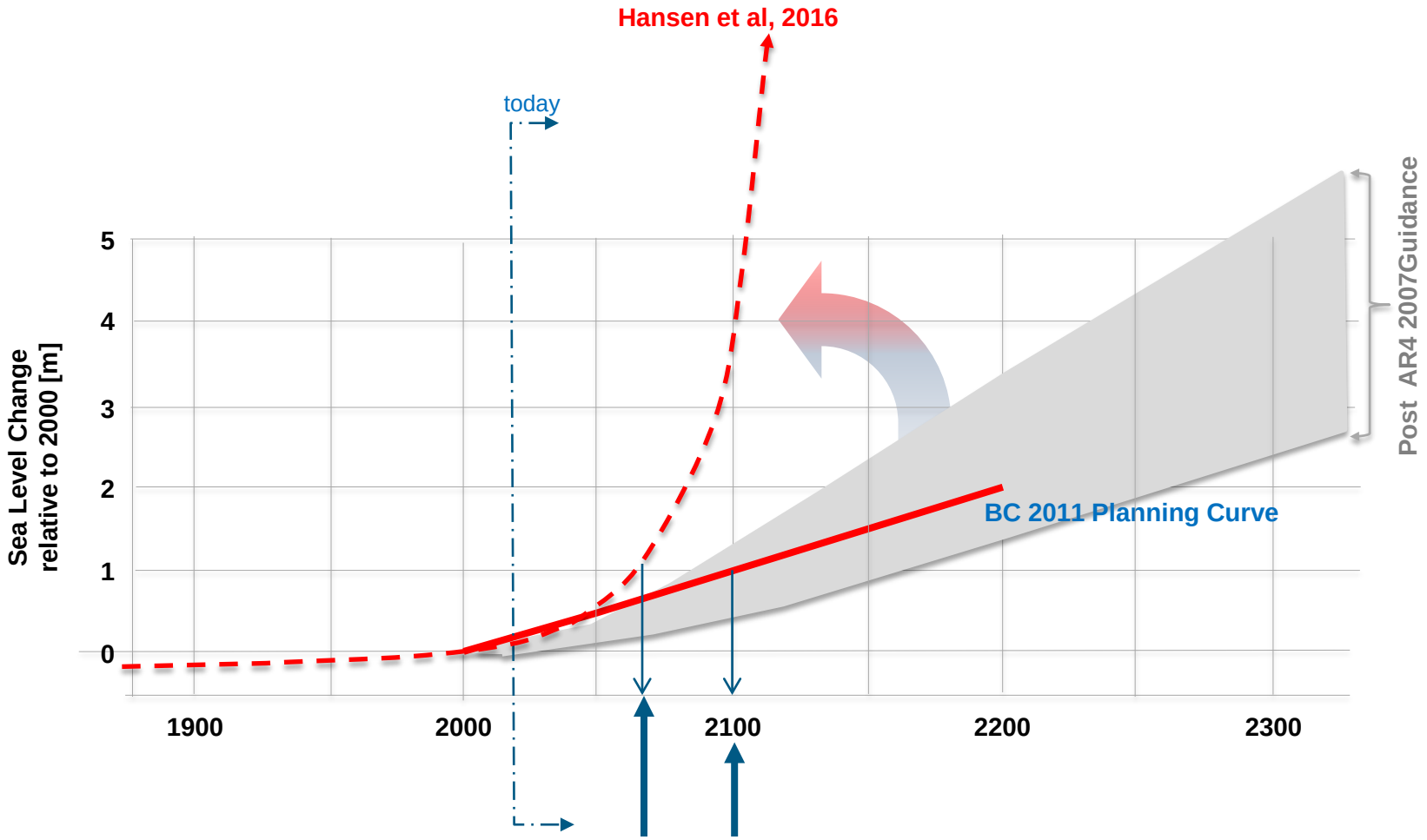
Standing Rainbow Disposal

Rainbow Disposal Underway

Local Area

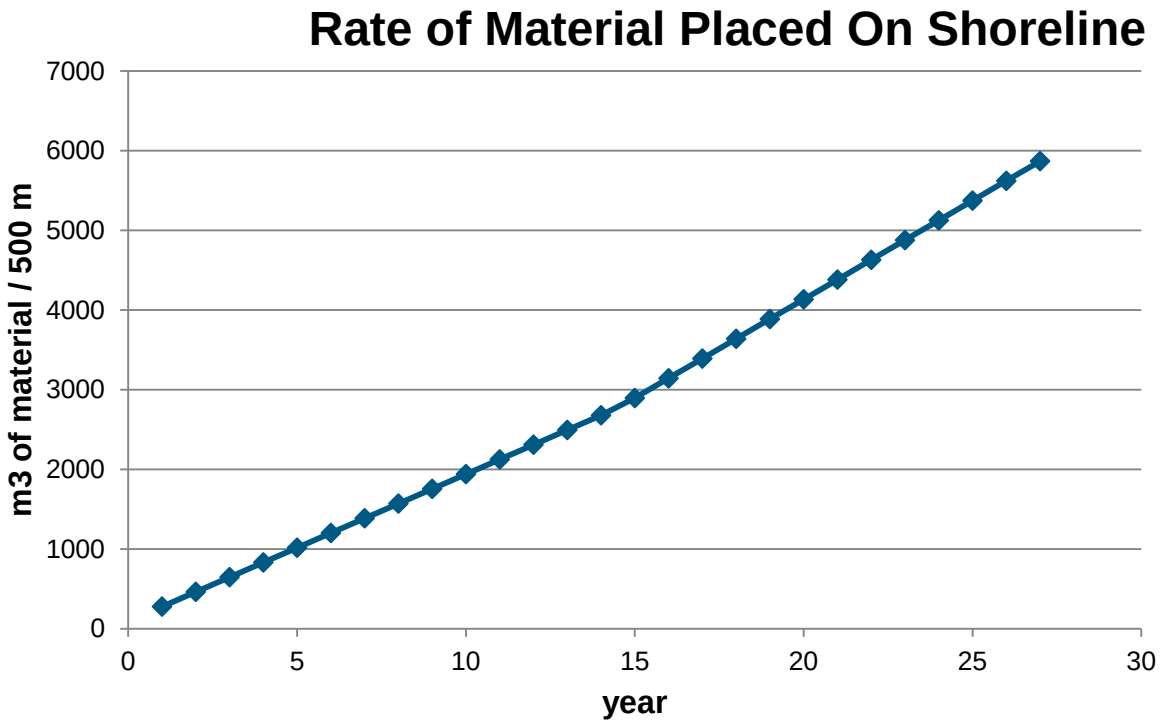

COMOX HARBOUR
Scale 1:15 000 (49°35'N) Échelle
COURTENAY RIVER
COURTENAY
COMOX
Courtenay Airport
GOOSE SPIT
Extensive salt marsh

Guidance 2017

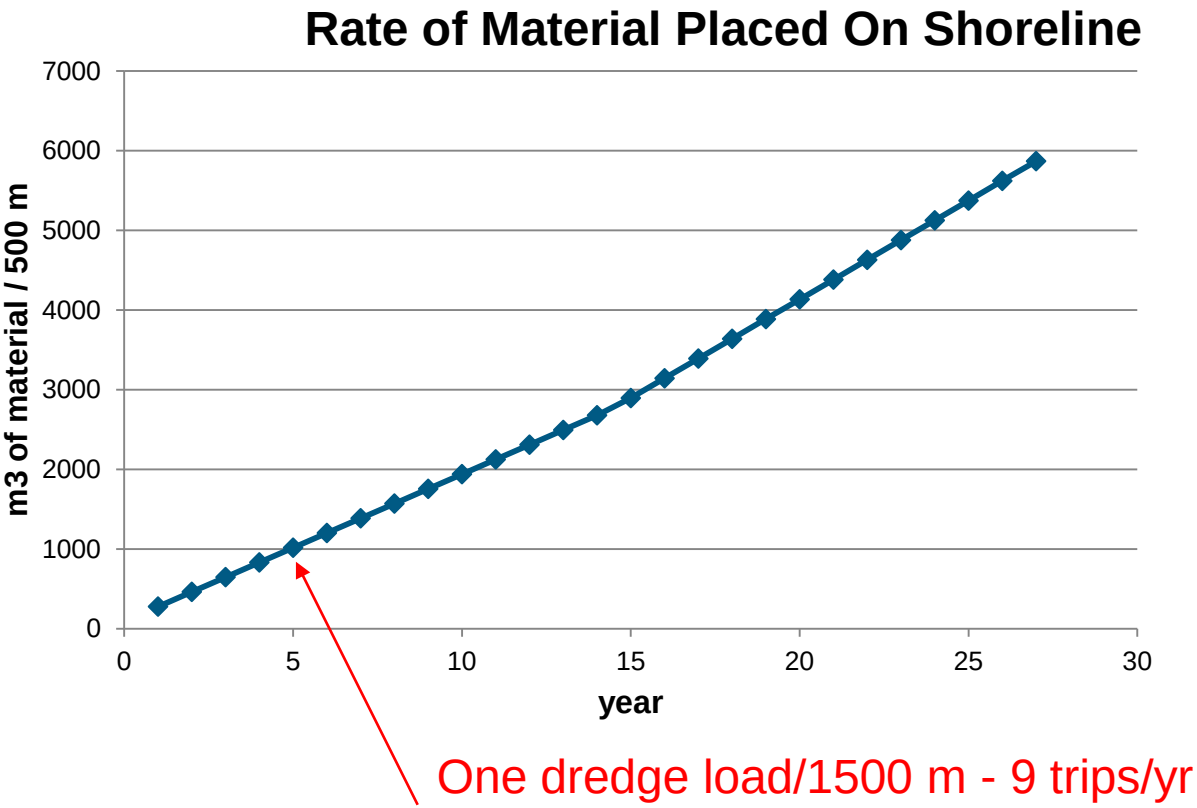


1 m of SLR is coming – 50 years, hopefully more

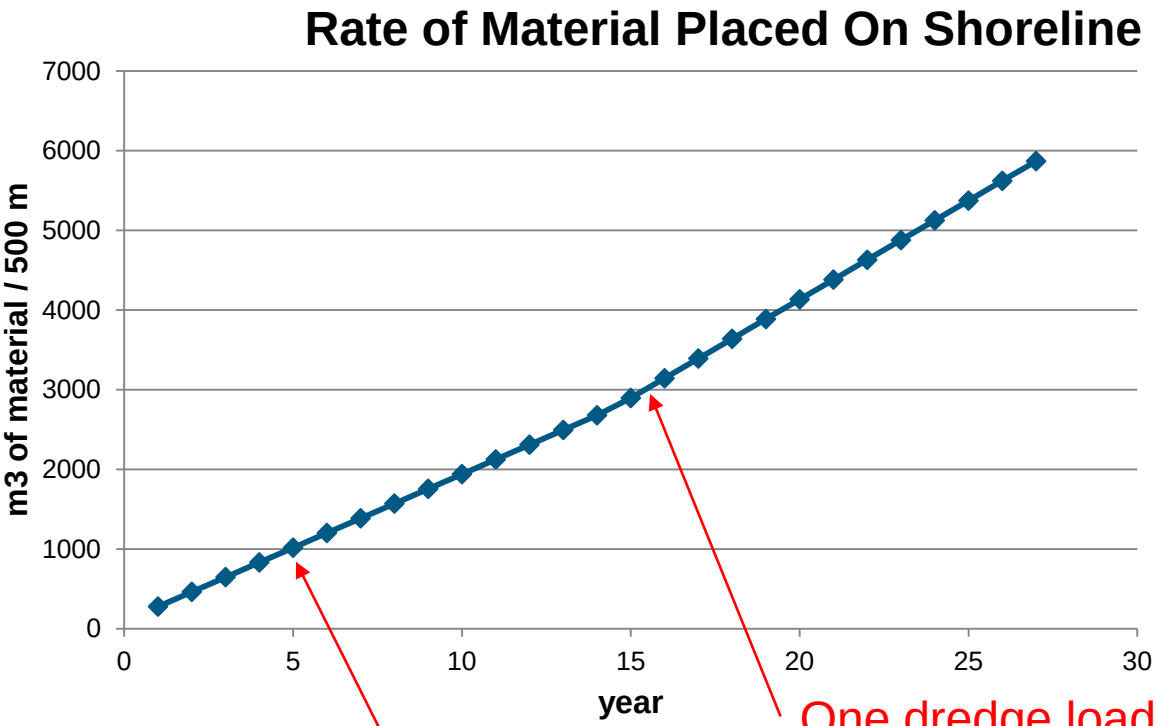
Rate of Supply (1:15 slope) 10 cm/yr



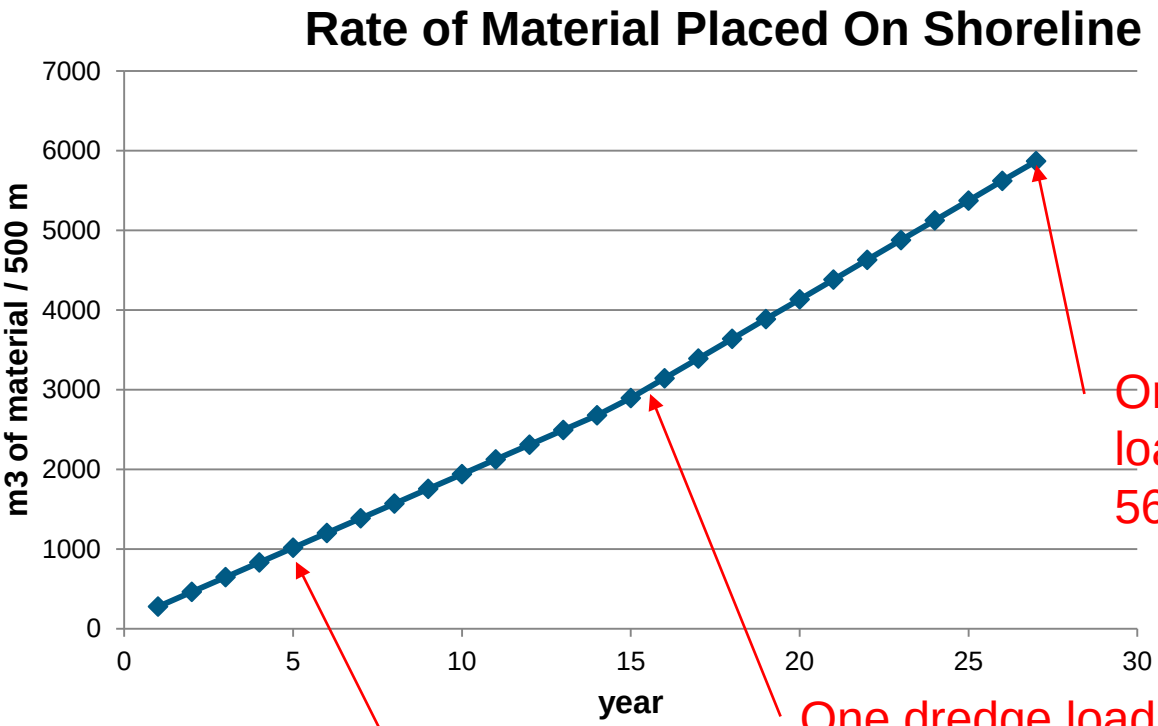
Rate of Supply (1:15 slope) 10 cm/yr



Rate of Supply (1:15 slope) 10 cm/yr



Rate of Supply (1:15 slope)



One dredge load/250 m 56 trips/yr

One dredge load/500 m - 14 trips/yr

One dredge load/1500 m - 9 trips/yr

Gaps, Questions and Next Steps

Gaps Questions and Next Steps

Known Knowns	Known Unknowns
-**Concept is feasible** -**Fine sand material dynamically stable** -**Interface is highly productive**	**-how much material can be placed at once?** **-will wave climate move it onshore fast enough?** **-how fast will vegetation take hold?** **-cost?**
Unknown Knowns	**Unknown Unknowns**
-Conceptual assessment! -Needs detailed evaluation! -Needs piloting and assessment!	


Questions?

Values that guide us

Our values keep us anchored and on track. They speak to how we run our business, how we express ourselves as a group, and how we engage with our stakeholders and inspire their trust.

Teamwork & excellence
We're innovative, collaborative, competent and visionary.

Customer focus
Our business exists to serve and add long-term value to our customers' organizations.

Strong investor return
We seek to reward our investors' trust by delivering competitive returns.

Health & safety, security and environment
We have a responsibility to protect everyone who comes into contact with our organization.

Ethics & compliance
We're committed to making ethical decisions.

Respect
We consistently demonstrate respect for all our stakeholders.