



36TH INTERNATIONAL CONFERENCE ON COASTAL ENGINEERING 2018

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The State of the Art and Science of Coastal Engineering

Countermeasure against Erosion behind Submerged Breakwater due to Sea Level Rise

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- 1. Insufficient sediment supply from rivers**
- 2. Interruption of sediment movement by port and coastal structures**

Detached Breakwater





Submerged Breakwater



Submerged Breakwater



Kuriyama and Banno (2016) showed that the shoreline on a beach protected by a submerged breakwater will **retreat 60 m over the next 100 years.**

Objective

To investigate the **effectiveness of countermeasures** against the erosion due to sea level rise and land subsidence using a shoreline prediction model.

Contents

- Outline of study site
- Future shoreline change under SLR and land subsidence
- Effects of countermeasures



Niigata Coast

Sekiya Diversion
Channel

Shinano River

Image © 2010 DigitalGlobe
Data © 2010 MIRC/JHA

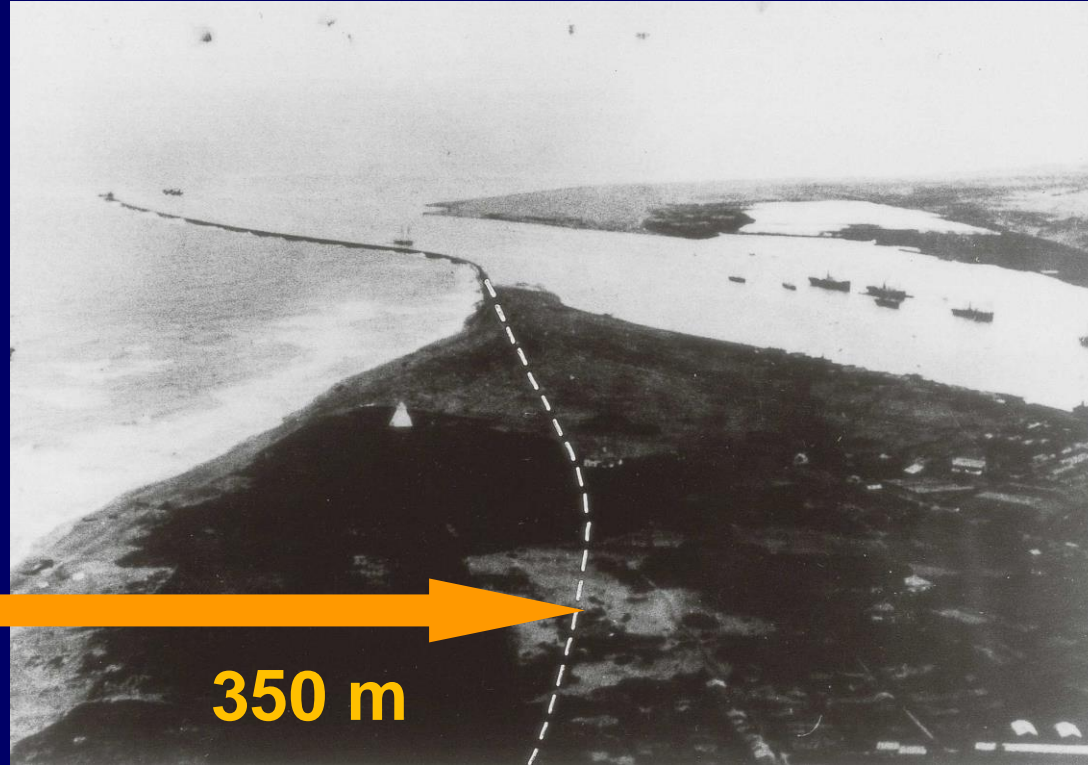
©2010 Google

画像取得日: 2008 年 10 月 1 日

37° 55' 26.93" N 139° 01' 50.30" E 標高 44 フィート

高度 39644 フィート

Niigata Coast (1915 - 1985)



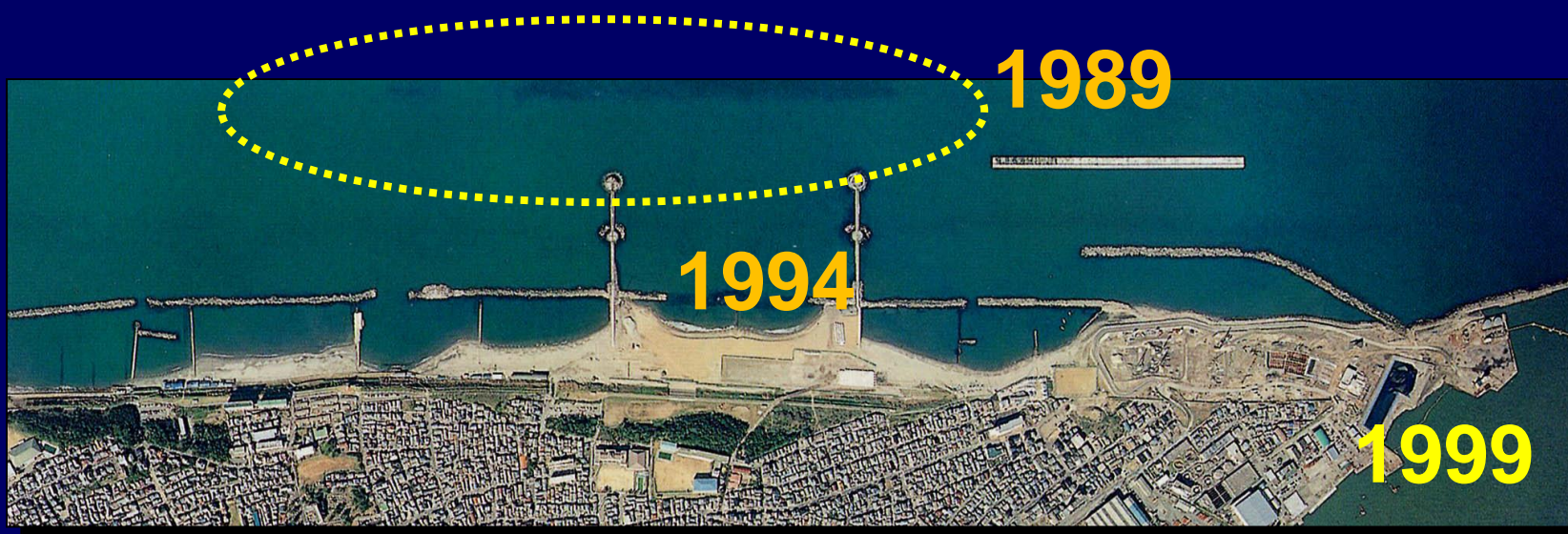
Causes of the beach erosion

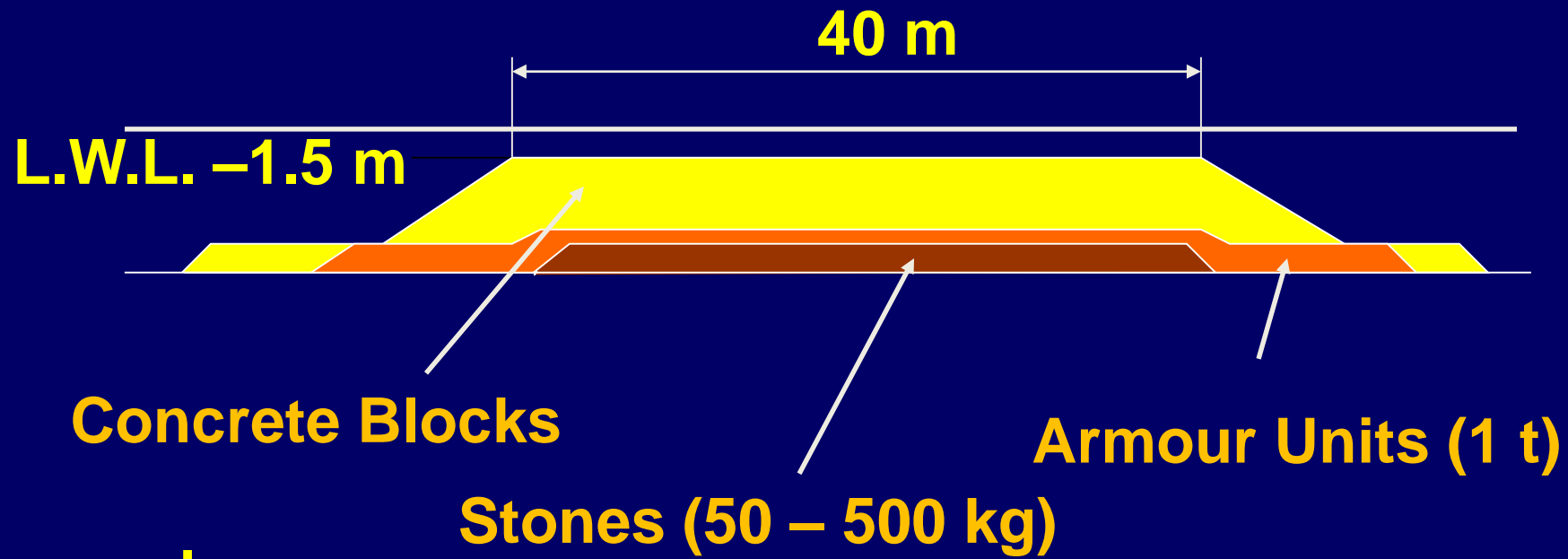
Constructions of a jetty and a breakwater

Openings of diversion channels

Land subsidence

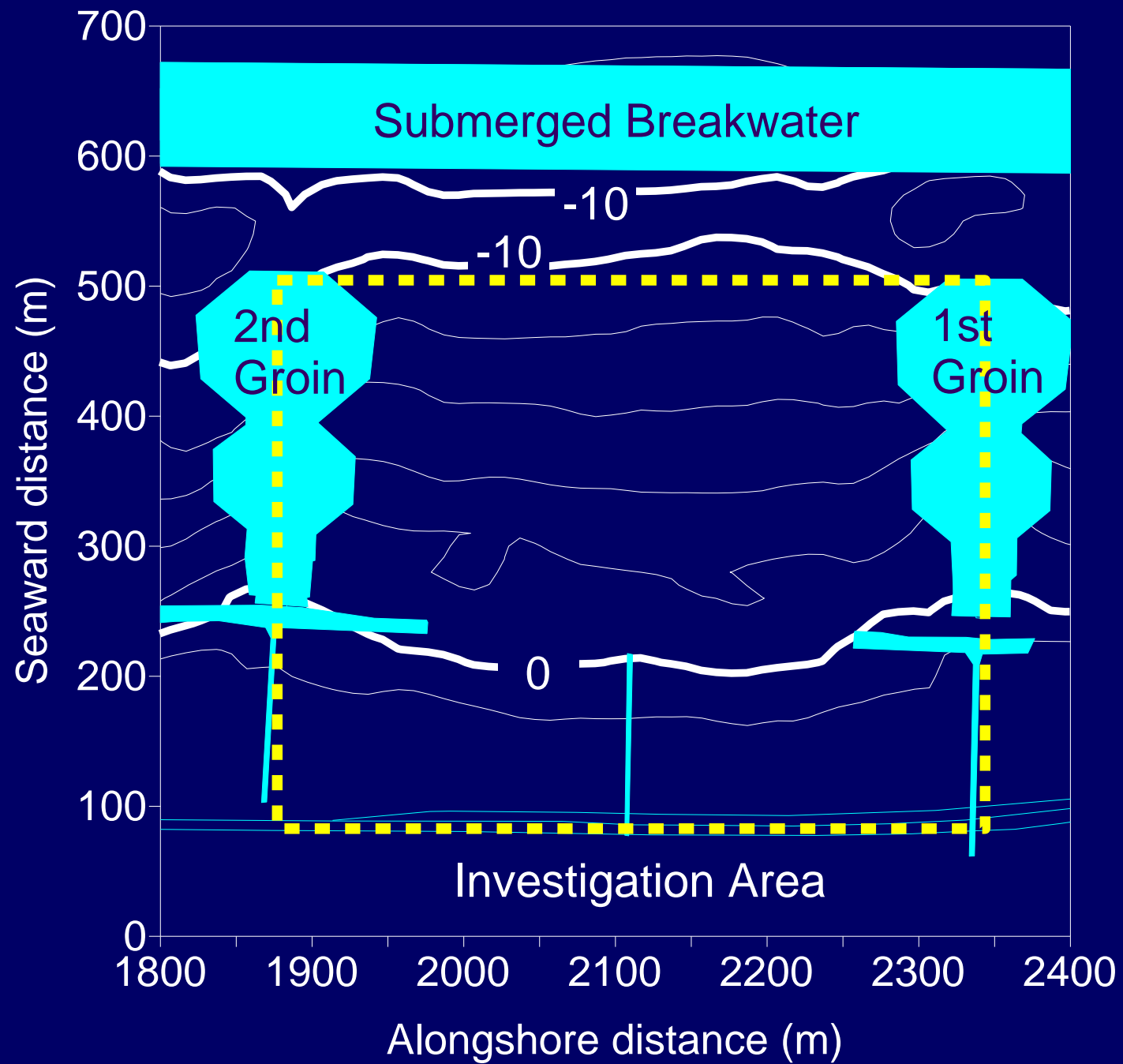




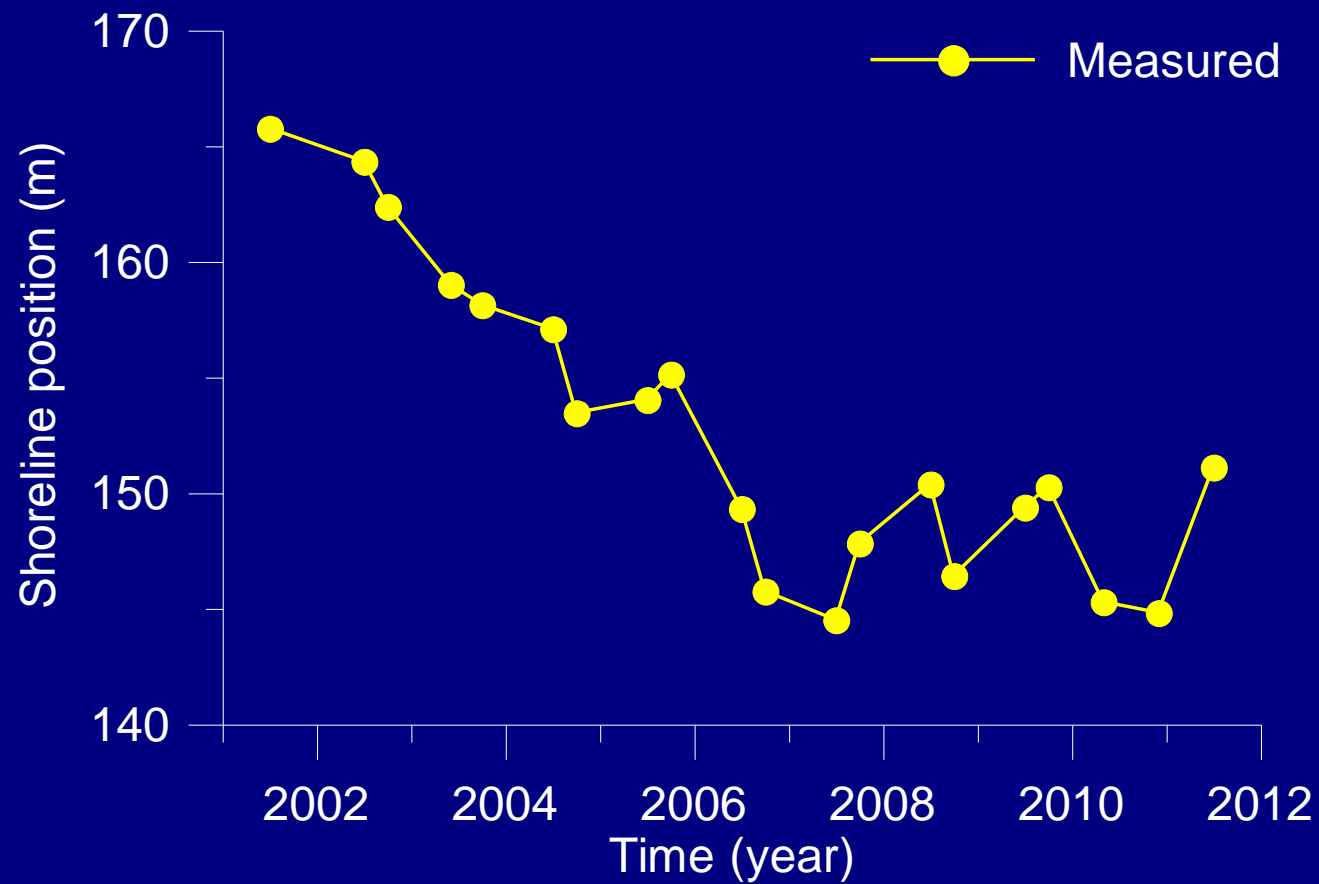
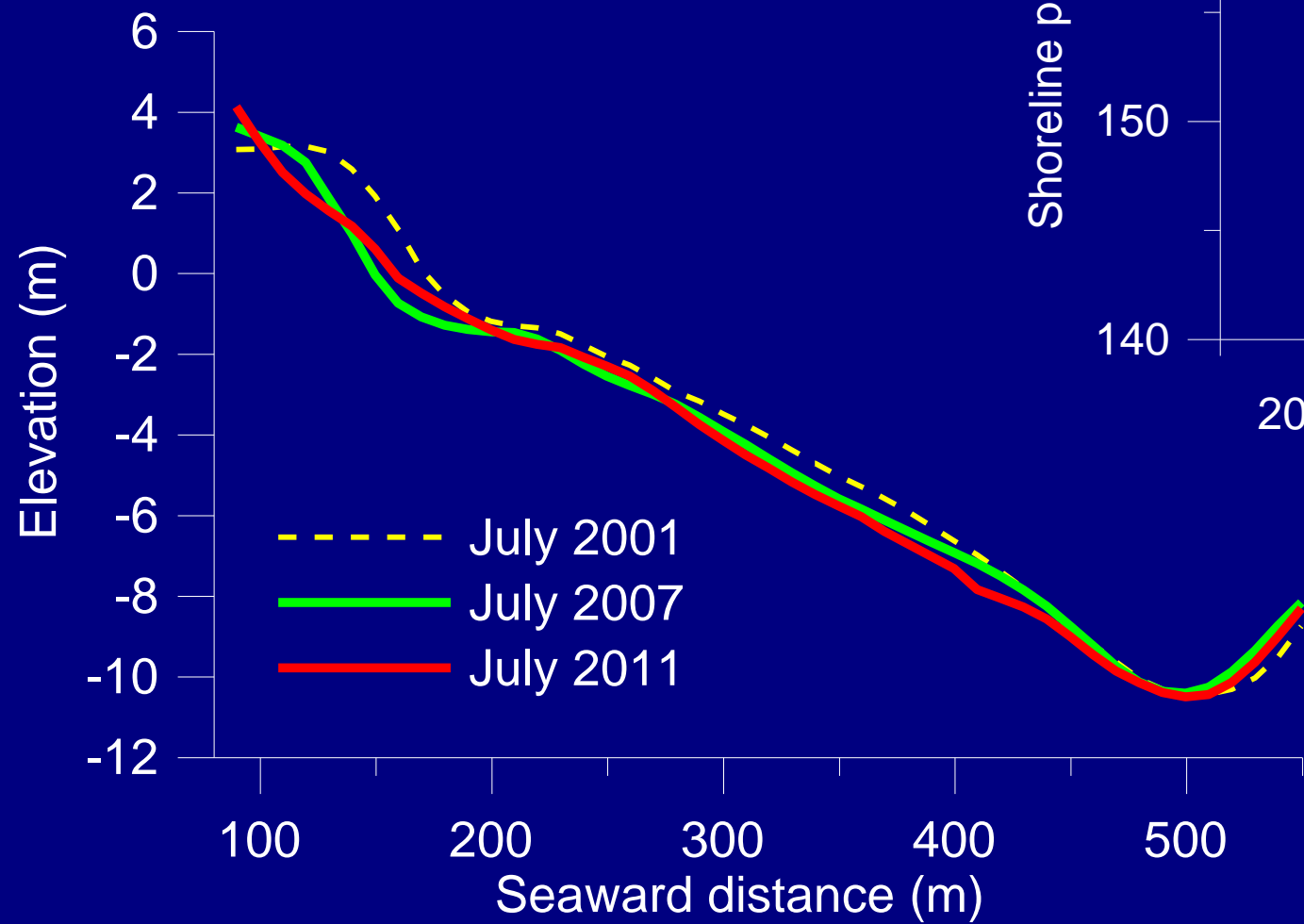


**Submerged
breakwater**

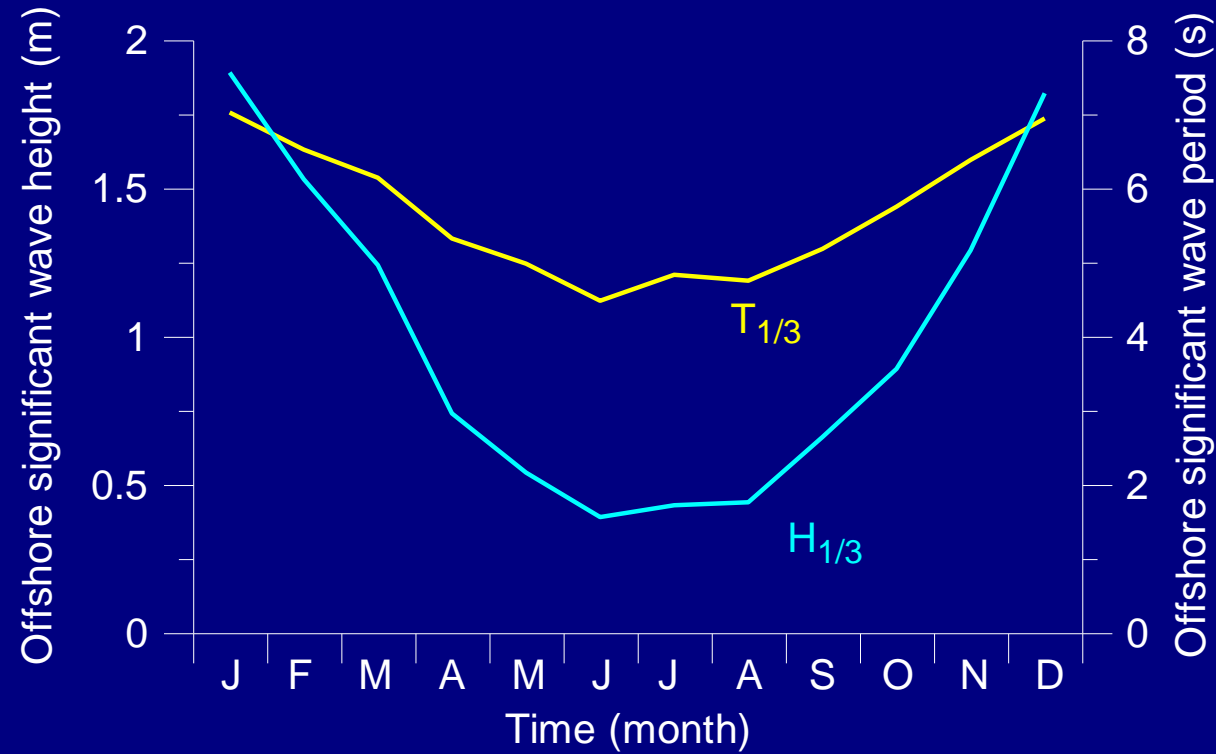




Beach Profile Change

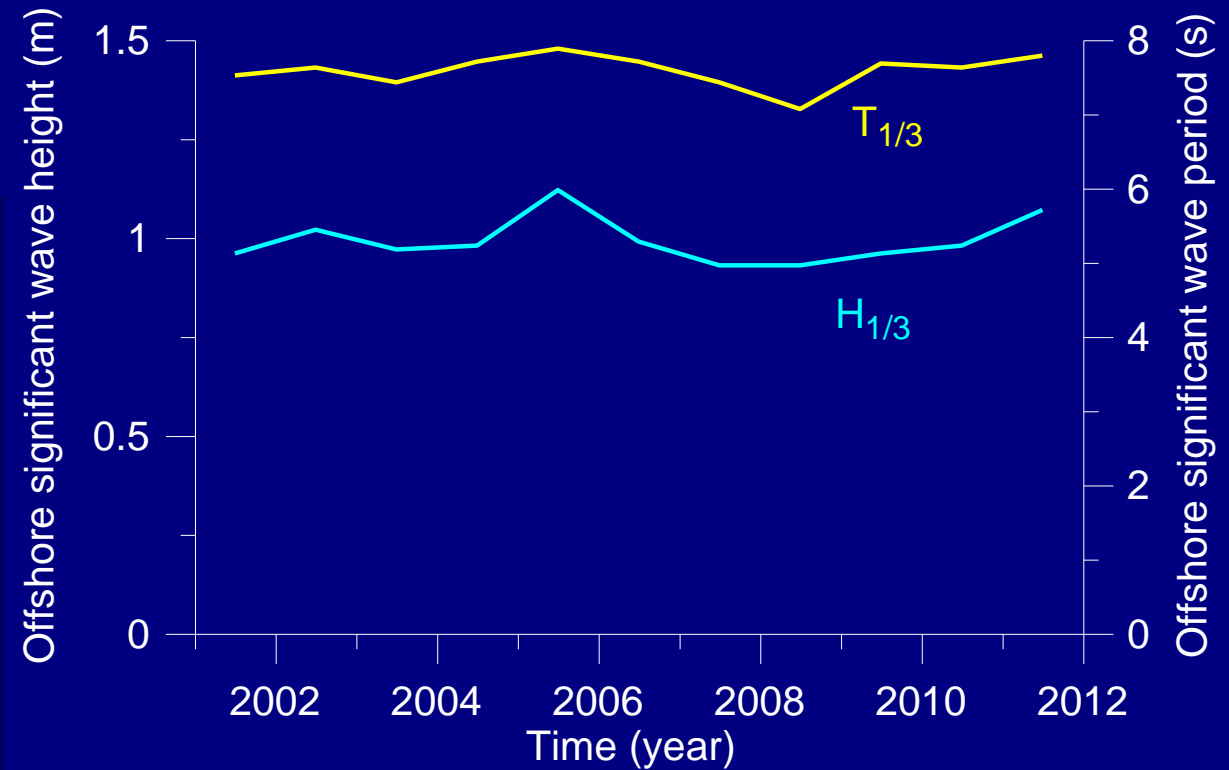


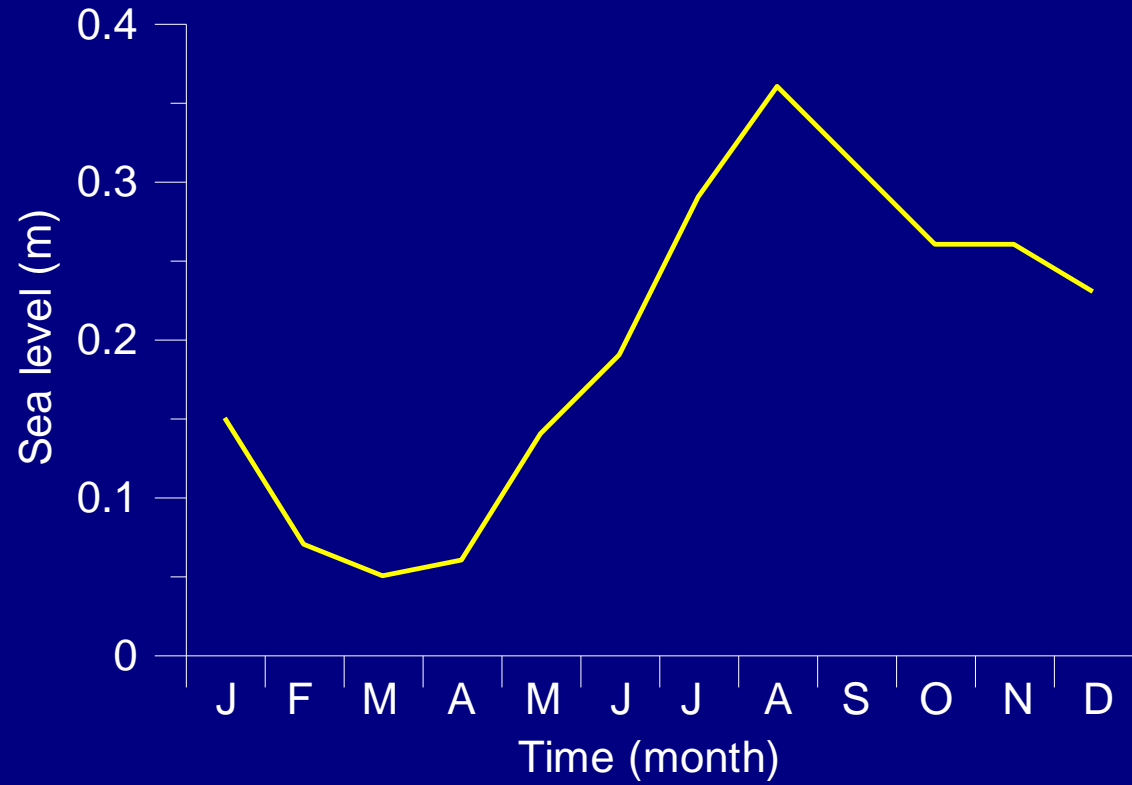
Shoreline Change



Monthly-Averaged Wave Height and Period

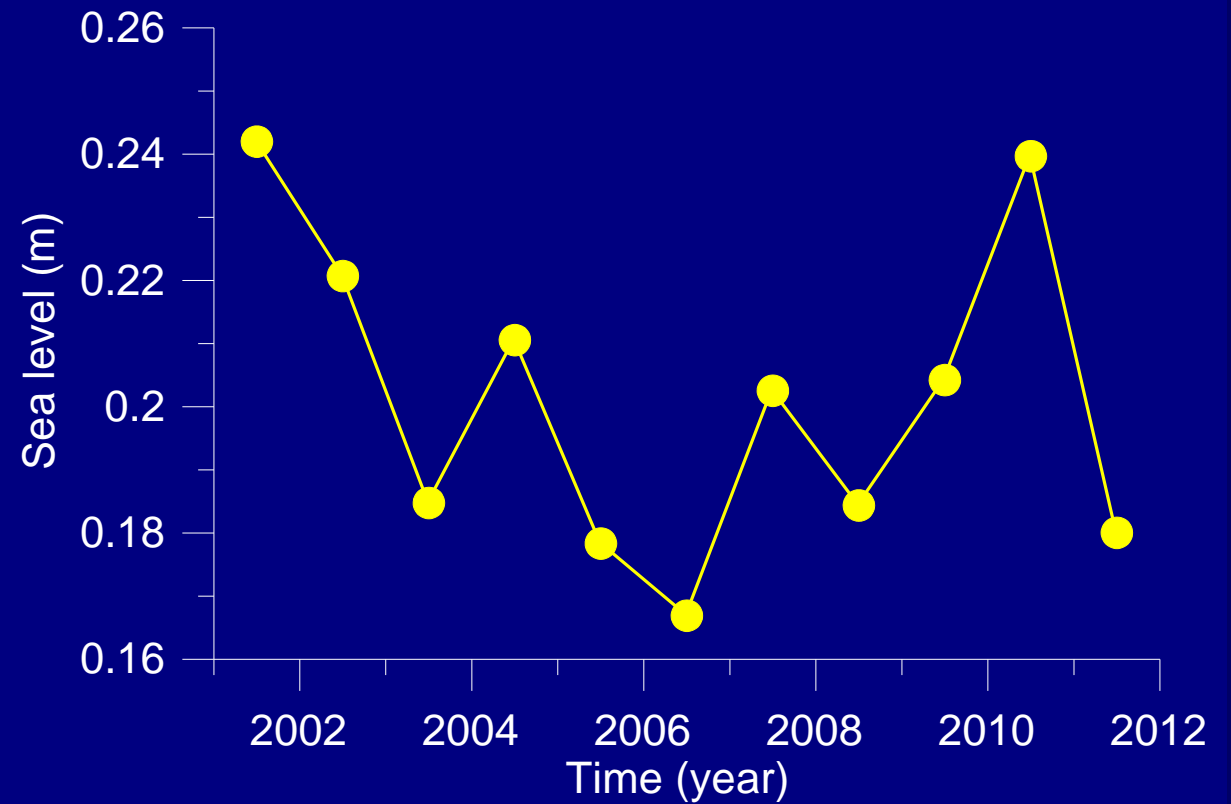
Yearly-Averaged Wave Height and Period



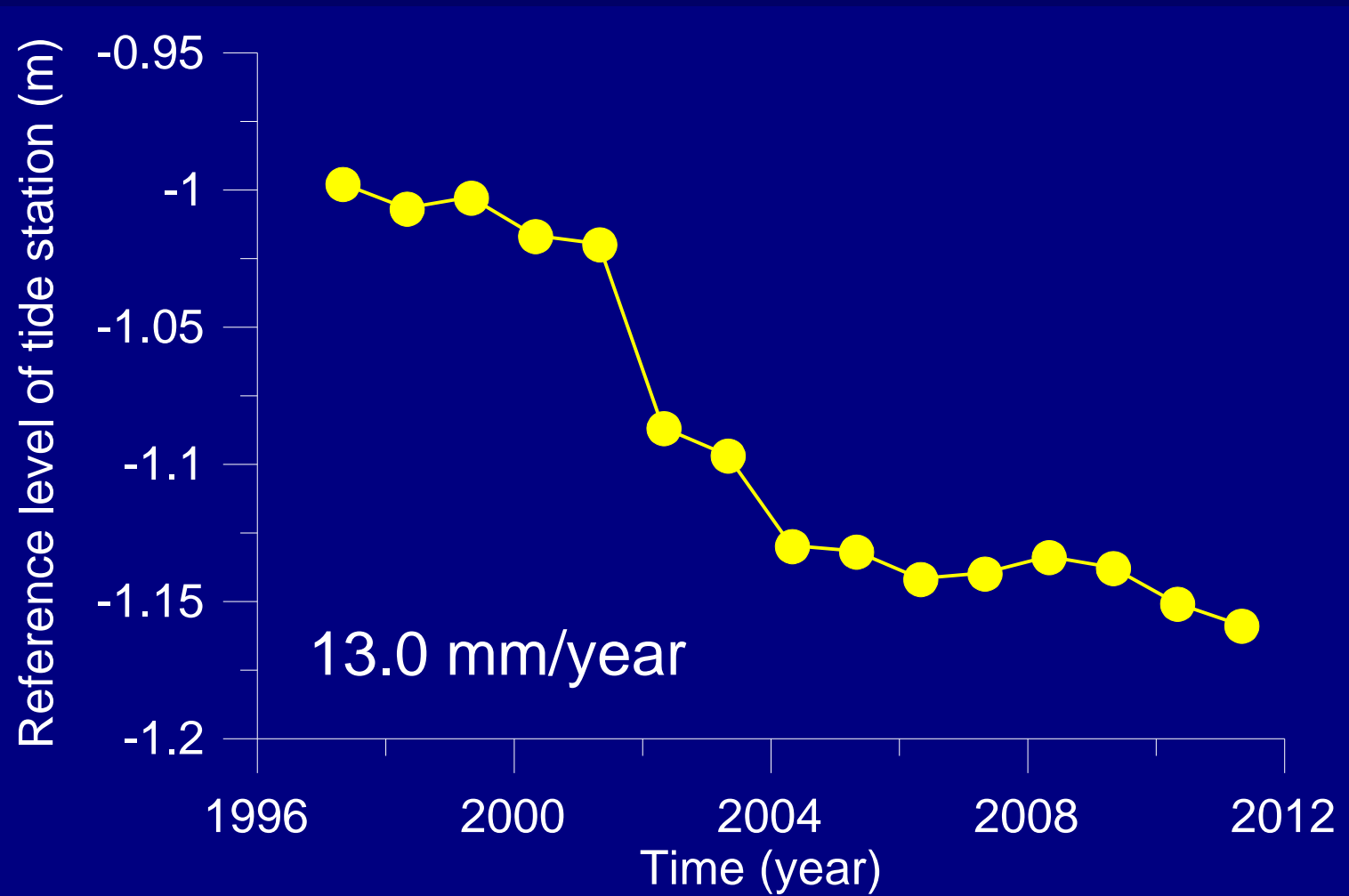


Monthly-Averaged Sea Level

Yearly-Averaged Sea Level



Land Subsidence



Methods

- **Shoreline prediction model:**
cross-shore sediment transport
- **Period:** 60 years from 2011 to 2061
- **Relative sea level change:**
Sea Level Rise (SLR) under RCP 8.5 scenario
(0.74 m/ 100 years) +
Land Subsidence (LS, 13.0 mm/year)
- **Waves:** 2001 to 2010
- **Time interval:** 3 months

Shoreline prediction model

(Kuriyama & Banno, 2016 CENG)

$$y_{s,i} = y_{s,0} + \sum_{j=1}^i \left(\frac{dy_s}{dt} \right)_j \Delta t$$

$$\left(\frac{dy_s}{dt} \right)_j = a_0 + a_1 + a_2 E_j^2 + a_3 E_j + a_4 y_{s,j-1}$$

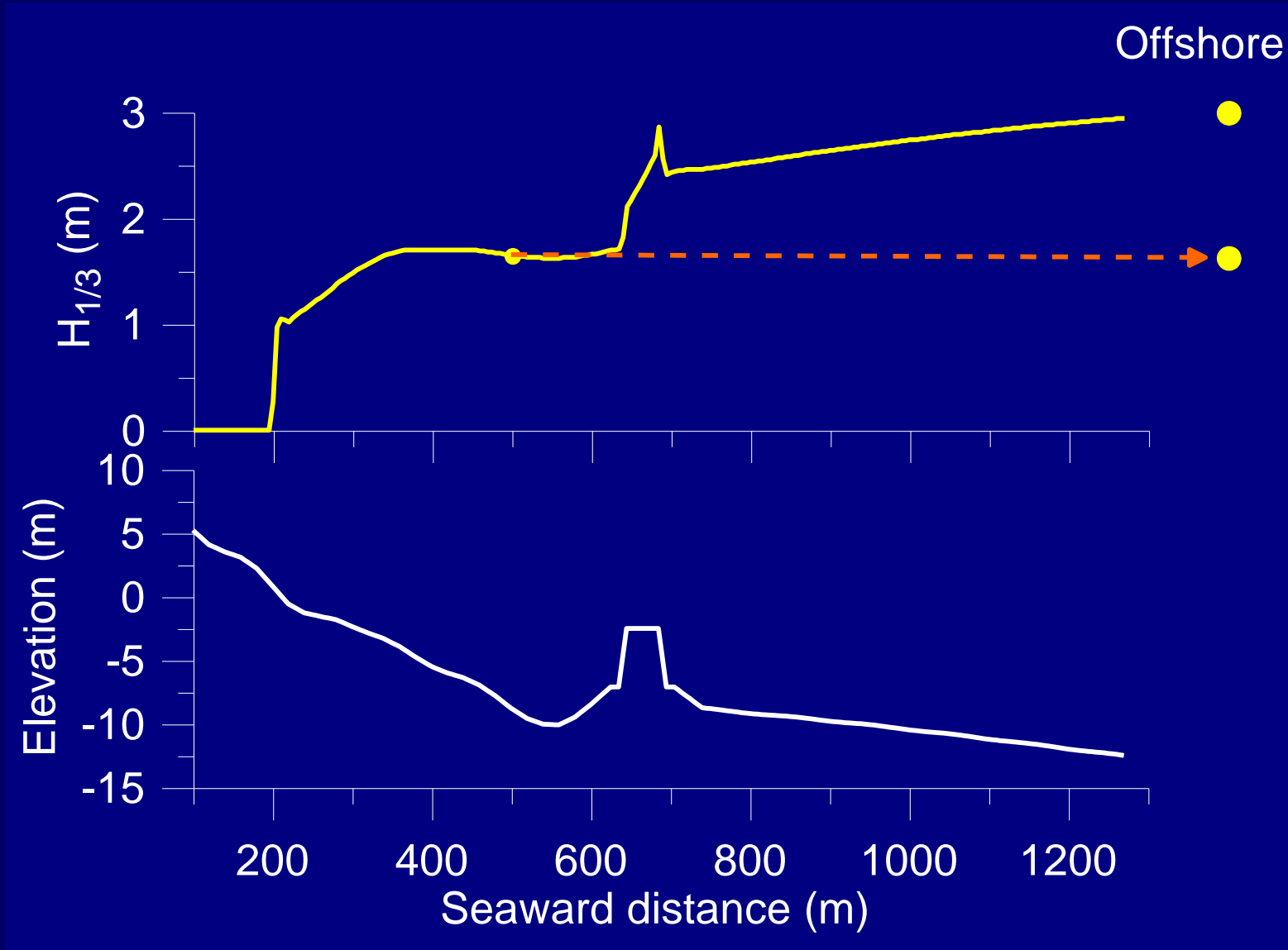
y_s : Shoreline position at $z = 0.5$ m

E : Offshore wave energy flux corrected with the consideration of energy dissipation over submerged breakwater

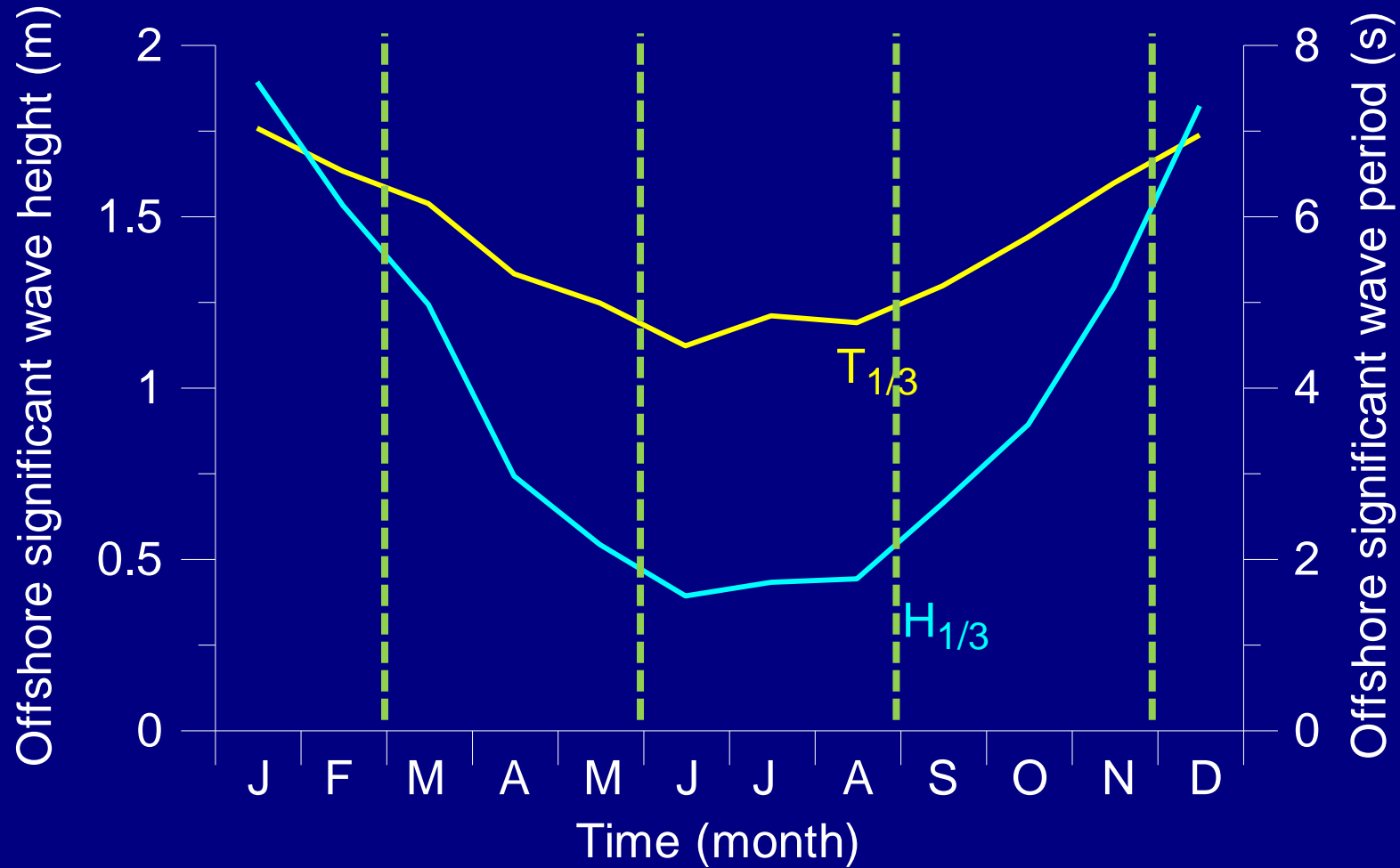
a_0 : Geometrically obtained shoreline change rate due to land subsidence, (amount of land subsidence)/(foreshore slope)

a_1 to a_4 : Free parameters

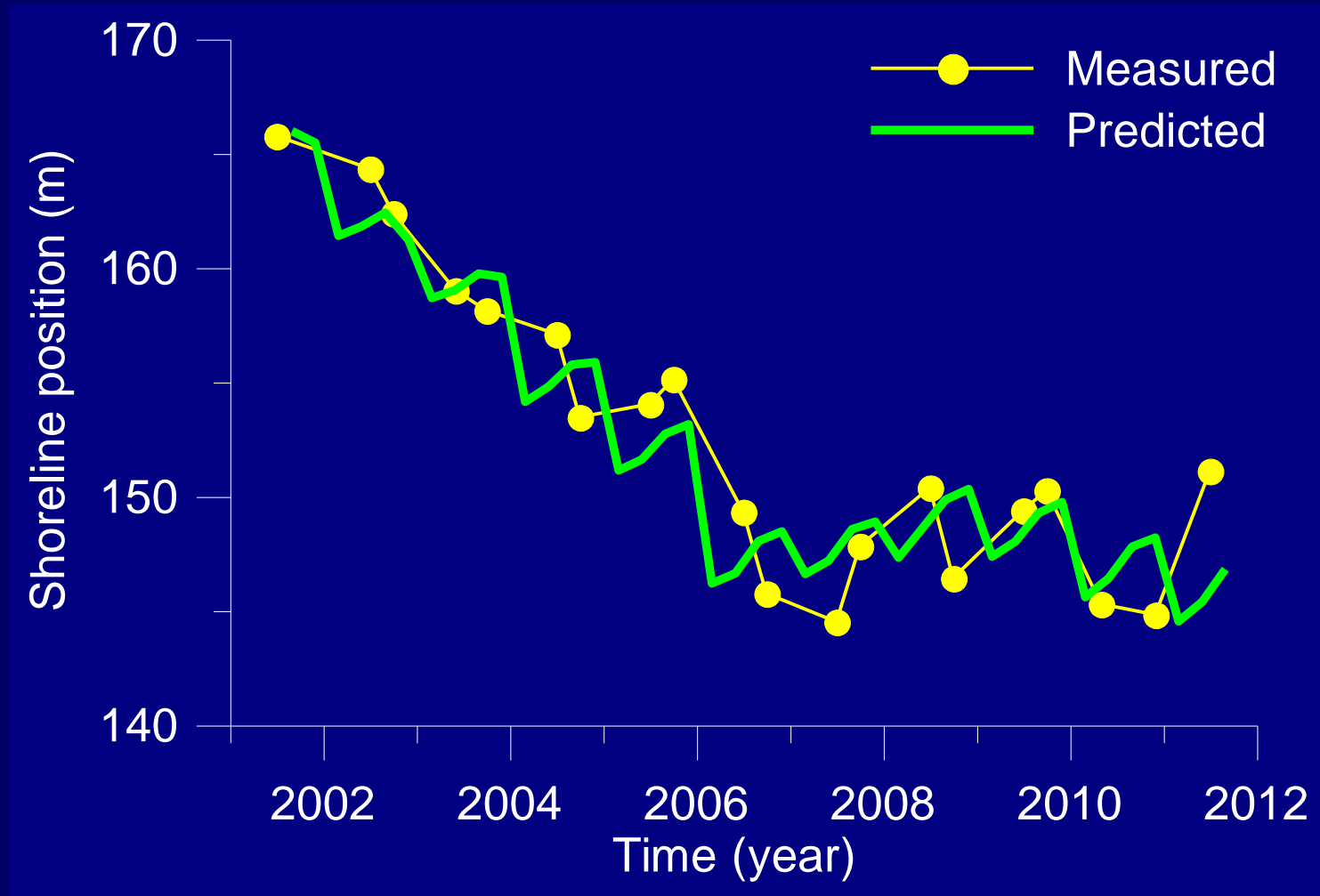
Consideration of energy dissipation over submerged breakwater



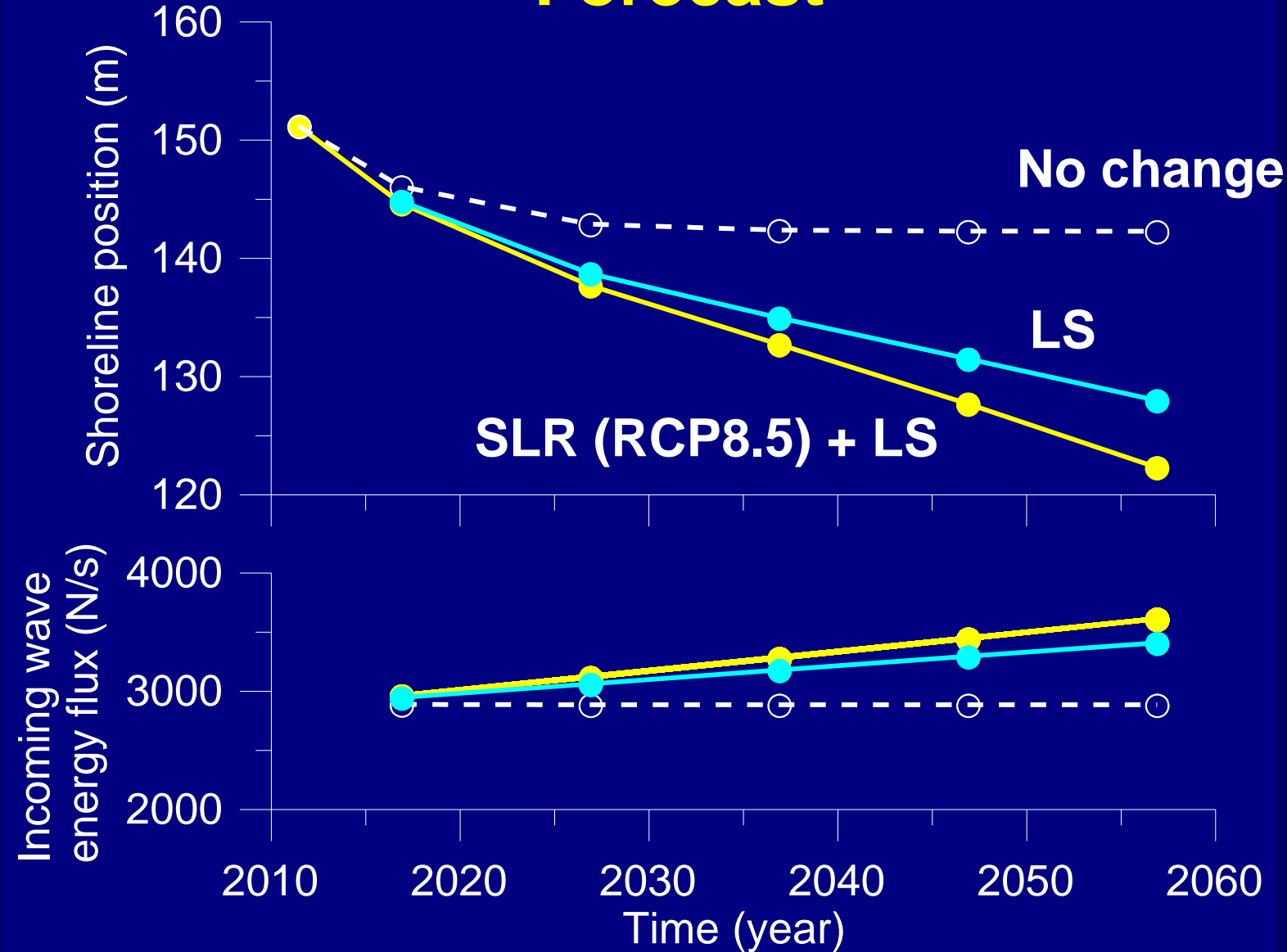
Monthly-Averaged Wave Height and Period



Calibration

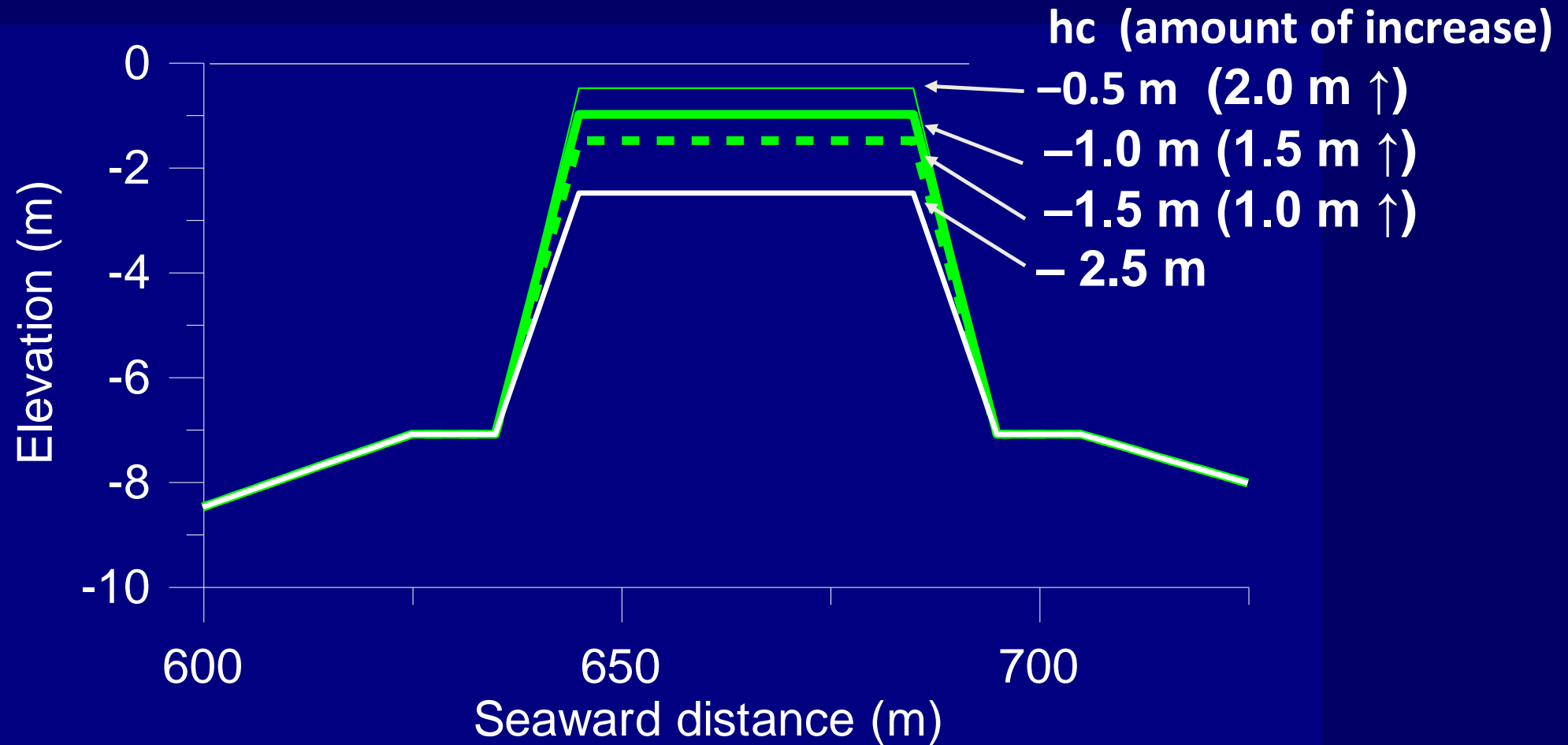


Forecast

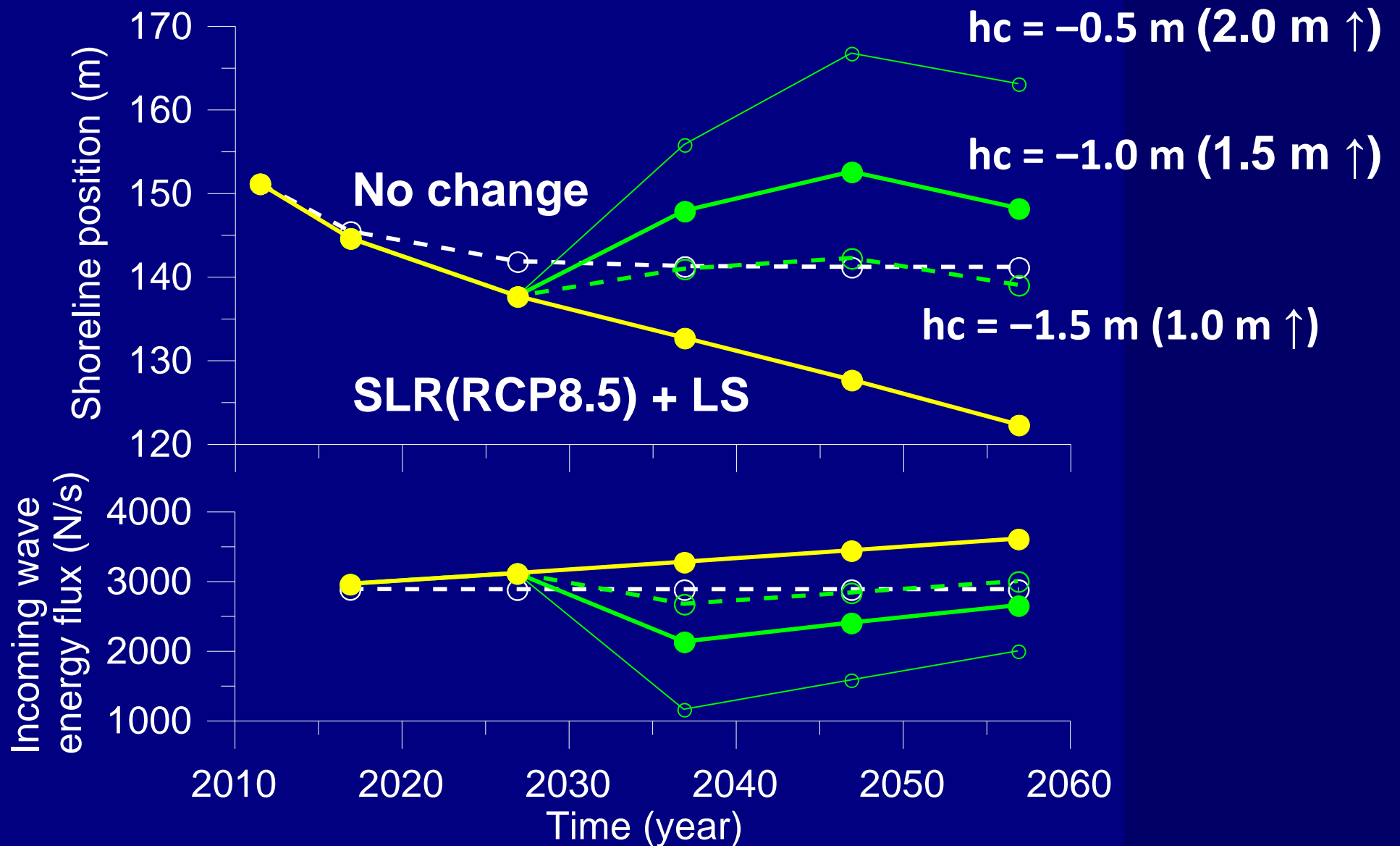


(Kuriyama & Banno, 2016 CENG)

Countermeasures



Effects of Countermeasures



Conclusions

- At the Niigata Coast, which is protected by a submerged breakwater, the shoreline is predicted to **retreat about 30 m in 60 years** due to **sea level rise** under the **RCP8.5** scenario and **land subsidence**.
- Even **a crown height increase of 1.0 m** induces **shoreline advance** of 5 m owing to the enhanced energy dissipation over the heightened submerged breakwater.

A photograph of a coastal scene taken from a grassy dune. In the foreground, there is a dense patch of green and brown coastal vegetation, including tall grasses and small shrubs. A wooden post is visible in the lower-left corner. Beyond the dune is a wide, sandy beach that curves along the shoreline. The ocean is visible in the background, with a long pier or breakwater extending into the water. The sky is filled with soft, grey clouds. The text "Thank you" is overlaid in the center of the image in a bright yellow font.

Thank you