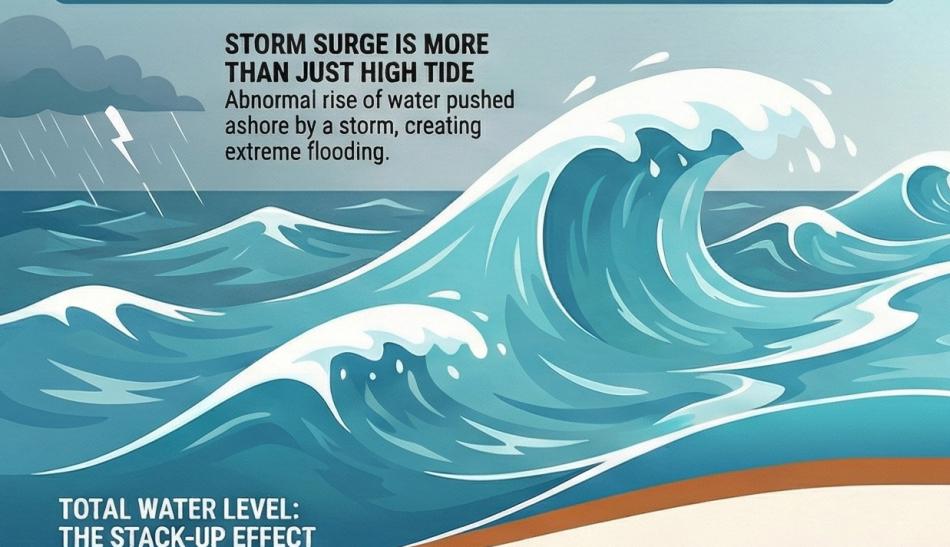


# Engineering the Defended Shoreline: How Coastal Structures Tame the Waves

## THE COASTAL CHALLENGE: UNDERSTANDING THE FORCES

### STORM SURGE IS MORE THAN JUST HIGH TIDE

Abnormal rise of water pushed ashore by a storm, creating extreme flooding.



### TOTAL WATER LEVEL: THE STACK-UP EFFECT



Design water level combines tide, storm surge, wave setup, and sea level rise.

### SEA LEVEL RISE AMPLIFIES FUTURE RISK

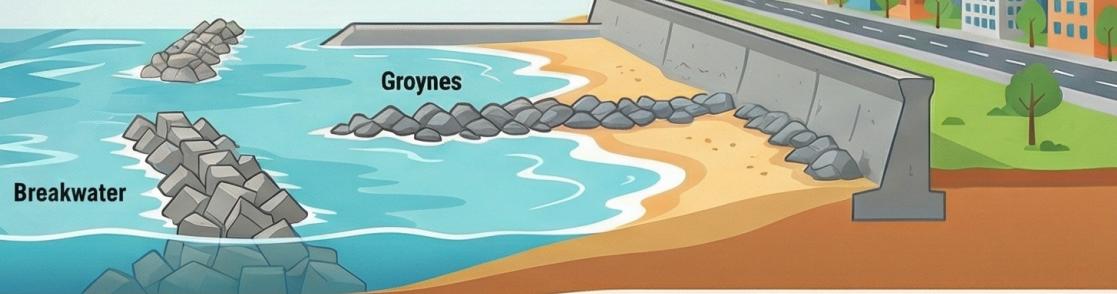


Global sea level is projected to rise by a likely range of 1 to 4 feet by 2100.

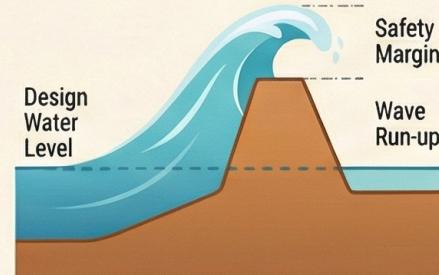
## THE ENGINEERING RESPONSE: DESIGNING FOR RESILIENCE

### A TOOLBOX OF COASTAL STRUCTURES

Engineers deploy various structures like seawalls, groynes, and breakwaters to manage wave energy.

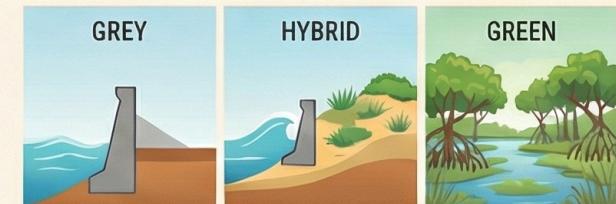


### DESIGNING THE CREST: HOW HIGH IS HIGH ENOUGH?



The structure's height is determined by calculating wave run-up and adding a safety margin.

## THE TRADE-OFFS: FROM GREY TO GREEN SOLUTIONS



Traditional hard structures offer protection but have lower adaptability and ecological value.

| APPROACH | FUNCTION             | ADAPTABILITY | ECOLOGICAL VALUE |
|----------|----------------------|--------------|------------------|
| Grey     | Resist forces        | Low          | Low              |
| Hybrid   | Combine grey + green | Medium       | Medium           |
| Green    | Work with nature     | High         | High             |