

Global Warming on Coastal Resilience Sea Waves and Wave Patterns

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DESCRIPTION

Sea waves are an essential and observable phenomenon of ocean dynamics, impacting coastal environments, marine navigation, and climate patterns. The behavior of sea waves is critical for effective coastal management, disaster preparedness, and marine ecosystem protection. Waves are the undulating surfaces of oceans and seas, created by the interaction of wind, gravitational forces, and the Earth's rotation. They are a fundamental aspect of oceanography and marine physics, influencing various natural and human systems.

Types of sea waves

Sea waves vary widely in size, shape, and energy. They are classified into different types based on their origin, formation process, and behavior [1]. The primary types of waves include:

Wind waves: These are the most common type of waves formed by the direct action of wind on the water's surface. Their size and speed depend on the strength and consistency of the wind, the duration of the wind's impact, and the fetch [2].

Swell waves: After wind-generated waves move away from their area of origin, they become swell waves. Swells are longer, more uniform, and generally smoother than wind waves. They can travel long distances across the ocean, maintaining energy and impacting coastlines far from their origin [3].

Tsunami waves: Caused by underwater seismic activity such as earthquakes, volcanic eruptions, or landslides, tsunamis are a distinct type of wave. Unlike typical wind-driven waves, tsunami waves have long wavelengths and low amplitudes in the open ocean, but they dramatically increase in height as they approach the shore, often resulting in catastrophic impacts on coastal areas [4].

Tidal waves: Often mistakenly referred to as "tidal waves," tides are large, periodic sea-level changes caused by the gravitational pull of the moon and the sun. While tides are not technically waves, they interact with sea waves in ways that affect coastal areas [5].

Rogue waves: Rare and powerful, rogue waves are unusually large and unpredictable waves that appear suddenly in the ocean. They are often the result of constructive interference between multiple wave systems, posing a significant hazard to marine vessels [6].

Interaction of waves with the coastline

As waves approach the shoreline, they undergo transformations due to decreasing water depth. When waves enter shallow coastal waters, they slow down, increase in height, and eventually break as they reach the shore [7,8]. This process, called wave shoaling, is crucial in understanding the energy dynamics in coastal areas. The breaking of waves is responsible for several important coastal processes, including:

Coastal erosion: Wave energy erodes beaches, cliffs, and shorelines over time. High-energy waves carry sand and sediment away from the shore, reshaping coastal landscapes. Over time, this can lead to the loss of valuable coastal land and habitats [9].

Sediment transport: Waves play a central role in moving sediment along the coast, a process known as longshore drift. Sediment transport helps form coastal features like sandbars, spits, and barrier islands, which can protect inland areas from wave impacts [10].

Wave refraction and diffraction: When waves approach the shore at an angle, they refract (bend) due to varying water depths. This bending of waves causes energy to concentrate or dissipate along certain parts of the coastline, affecting erosion patterns. Diffraction occurs when waves pass through obstacles, redistributing wave energy across the shoreline.

CONCLUSION

Sea waves are a dynamic and influential force that shapes our coastlines, affects marine ecosystems, and impacts human activities. By understanding wave formation, characteristics, and interactions with coastal areas, we can better prepare for and mitigate the potential hazards posed by waves, especially as

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climate change exacerbates these impacts. Advances in wave research and technology offer promising solutions for enhancing coastal resilience, supporting marine safety, and even generating renewable energy.

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