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Wave propagation through mangrove forests in the presence of a viscoelastic bed

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Abstract

The influence of viscoelastic ocean beds on the characteristics of surface waves passing through mangrove forests is analyzed under the assumption of linearized water wave theory in two dimensions. The trunks of the mangroves are assumed to be in the upper-layer inviscid fluid domain, whilst the roots are inside the viscoelastic bed. The associated equation of motion is obtained by coupling the Voigt's model for flow within the viscoelastic medium with the equation of motion in the presence of mangroves. The modified dynamic conditions are coupled with the kinematic conditions to obtain the boundary condition at the free surface and the interface of the two fluids consisting of the upper layer inviscid fluid and the viscoelastic fluid bed. To understand the effects of bed viscosity as well as elasticity on energy dissipation, the complex dispersion relation associated with the plane progressive wave is derived and analyzed. Effect of physical parameters associated with mangroves and viscoelastic bed on wave motion in surface and internal modes are computed and analyzed to understand their roles in attenuating wave effects. The present model will be useful in the better understanding of wave propagation through mangroves in the coastal zone having muddy seabed.

Keywords: Mangrove forest; gravity waves; viscoelastic bed; dispersion relation.

1. Introduction

In recent decades, coasts and estuaries are increasingly exposed to various catastrophic events such as rising sea level, extremely varying weather and disastrous climate events. Some of these events are due to gradual physical processes; namely melting of glaciers, coastal erosion and nearshore morphological changes whilst, others are due to extreme events such as tsunamis and storm surges. Another challenge along the coast is the upsurge in human population. Often wave energy induced by the cyclonic winds substantially exceed tidal energy leading to catastrophe in the coastal zone (see Mitchell et al. (2006)). The tropical cyclones and tsunami in the past two decades have significantly affected the coastal community across the planet. Thus, keeping the possibility of an increase in the frequency of powerful tropical cyclones due to climate change in mind, the establishment of effective

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