A new numerical modeling methodology was developed to accurately determine nearshore wave characteristics and coastal flooding for island coastal areas due to hurricanes. Because wave setup over shallow reef areas can be larger than the storm surge effects due to hurricane wind stress and inverted barometer effect, the spatial modeling of the wave transformation process is important in determining the inundation at the shoreline. An integrated hydrodynamic model was developed to characterize the spatial (two-dimensional) variability of the wave field, the subsequent rise in the mean water level, and the spatial characteristics of the coastal flooding effects. The integrated numerical modeling approach was developed to enable practical application to specific sites of interest using PC-based systems.