Shoaling of Solitary Waves

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Shoaling processes of solitary waves are studied via numerical experiments using a fifth order pseudo-spectral method adapted to a varying bottom bathymetry. We observe how the rate of shoaling is affected by nonlinearity, dispersion, and beach slope for a wide range of parameters. The numerical results agree well with Green's Law for small values of nonlinearity (a/h) and gradual slopes, but begin to differ significantly at values of nonlinearity approximate to 0.05 for a range of beach slopes. The rate of shoaling appears to change during the shoaling process, and for larger values of nonlinearity $a/h > 0.2$ does not appear to follow a power law. It is well known that the adiabatic approximation of a solitary wave yields the shoaling wave amplification is inversely proportional to the depth. We found that this approximation represents a very limited and local behavior of the shoaling process. In addition, we propose exact solutions for a generalization of Green's Law in the cases of either strong nonlinearity with weak dispersion or weak nonlinearity with strong dispersion.