5. STORM SURGE AND WIND-WAVE RESPONSE

5.1 INTRODUCTION

Storm surge is the response of mean water level to the high winds, pressure differential, and rainfall associated with tropical (hurricane) and extratropical (northeaster) storms. The forces which appear to elicit the greatest responses are wind-induced shear, which tends to push water onto the beach, and the inverse barometer effect, which elevates the water level under the eye of a hurricane. For example, Fig. 5.1 displays the observed tides and storm surge associated with Hurricane Carla in the Galveston, Texas area. A complete discussion of all the relevant forces and the equations governing flows induced by storms can be found in the Shore Protection Manual, U.S. Army Corps of Engineers (1984). Solutions to idealized cases are given by Bretschneider (1966a) and Dean and Dalrymple (1984). The dependence of these solutions on nominal water depth will be examined in order to postulate some of the possible effects of long-term sea level rise.

The stress applied to the water by the high winds associated with storms is also responsible for wave generation. Bretschneider (1959) developed a family of curves from non-dimensional significant wave height induced by a hurricane, shown in Fig. 5.2. Wind waves are affected by sea level (water depth) both in their generation and as they propagate over the continental shelf. Shallow water limits the height a growing wave can attain due to steepness-induced breaking and bottom friction, while bottom friction continues to drain energy from the waves as they propagate out of the generation region. Wave generation in shallow water and losses due to bottom friction will be briefly examined in order to identify effects of depth, and hence the consequences of long-term sea level rise. Reference can be made again to the Shore Protection Manual and Bretschneider (1966b) for information on these topics.

5.2 STORM SURGE

For the idealized situation shown in Fig. 5.3a where the continental shelf is uniform in depth, we consider a spatially and temporally uniform surface shear stress due to the wind associated with the storm. According to Dean and Dalrymple (1984) the set-up, η, for steady-state conditions is given by