Storm Surges Congress, Hamburg, Germany
13–17 September 2010
SSC2010-166

Human Impacts on Estuarine Storm Surge Levels

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1 Introduction

In the German North Sea estuaries of Ems, Weser and Elbe significant changes of ordinary tidal and storm surge levels have occurred after the second World War. The public and scientific discussion on the reason(s) for these developments are still go-ing on. It is often steered by interests of stakeholders, blaming partly coastal protec-tion measures and partly deepening of estuarine waterways. Aim of this contribution is to analyze the data in order to substantiate the discussion. The means of the analysis are explanatory highlighted in the abstract for one of the three estuaries.

2 Very High Storm Surge Levels in the Ems-Dollard estuary since 1962

The storm surge levels of February 1962 are effected by a then still open dyke line in the upper part of the estuary allowing the flooding of large areas. After the closure of that gap in 1967 the storm surges of January 1976, of January 1994 and January 1995 have the same boundary conditions above MHWL. The only changes in the period between 1976 and 1994 have successive deepenings and streamlining of the estuarine waterway between Pogum and Papenburg. The effect on the peaks of storm surges is evident. E. g. the storm surges of January 1995 and particularly of January 1994 have relatively high peaks in comparison to that of January 1976 and between Emden and Leerort also to that of February 1962 though their peaks at Borkum in the mouth of the estuary have been significantly higher. These changes in the upper part of the estuary is linked with the waterway deepening and streamlining there. The peaks of the storm surge of November 2006 are mainly determined by the closure of the Ems storm surge barrier: The peak levels downstream of the barrier are higher than those of 1962 and 1976 in relation to the ones at the estuarine mouth.

3 Change of threshold level in the Weser estuary

The statistical classification of storm surge levels DIN 4049 defines the lowest thresh-old for storm surges by the lowest of the 200 highest set-ups within 20 years. This threshold has climbed in the Weser estuary from the period 1968-87 to 1980-99 at the gauge Elsfleth from 112 cm to 120 cm and at the gauge Oslebshausen from 117 cm to 132 cm. Major impact is the deepening of the Lower Weser in the 1970s. The erection of storm surge barriers at the mouth of three tributaries of the Weser is of low importance since their closure is only executed for a much smaller number of higher storm surge levels.

4 Percentiles of set-up in the Elbe estuary

The 95- and 99,5-percentiles of the set-up storm surges at the tidal gauges of Cux-haven, Stadersand, St. Pauli and Over increase significantly between 1964 and 1975 and again after a slight lowering between 1978 and 1985. The increase is much more pronounced at the upstream located gauges than at Cuxhaven at the mouth. Contra-dictory the lowering of the percentiles does show such significant differences be-tween the data for the gauge Cuxhaven and those ones for the upstream located gauges. This indicates that the reason for these changes are the subsequent deep-enings to a nautical depth of 12 m between 1964 and 1967 and to 13,5 m between 1974 and 1978.