Geophysical Research Abstracts
Vol. 13, EGU2011-7576, 2011
EGU General Assembly 2011

Urban tidal flooding in Normandy (Le Havre, NW France)

Sylvain Elineau (1), Anne Duperret (1), Pascal Mallet (2), and Rémi Caspar (3)

(1) Université du Havre, FRE 3102 CNRS Laboratoire Ondes et Milieux Complexes, 53 rue de Prony BP540, 76056 Le Havre cedex, sylvain.elineau@univ-lehavre.fr, anne.duperret@univ-lehavre.fr, (2) Communauté de l'Agglomération Havraise (CODAH), Direction pour l'Information sur les Risques Majeurs, Hôtel d'Agglomération, 19 rue Georges Braque, 76085 Le Havre cedex, pascal.mallet@agglo-havraise.fr, (3) Météo-France, station du Havre, Quai des Abeilles, 76600 Le Havre, France, remi.caspar@meteo.fr

Natural hazards such as coastal erosion of natural chalk cliffs coastline and tidal flooding in urban context are observed in Upper-Normandy region (NW France). Le Havre town is submitted to extreme natural events like urban tidal flooding in relation with tidal docks occurrence in the centre of the town. The study area is located along the English Channel at the mouth of the Seine river estuary, with a maximal tidal range of 8.14 m. A part of the urban tidal docks are directly connected to the sea and are equipped of tidal gauges since 1938, whereas some others are regulated in order to obtain a constant sea level for the harbor activity.

Le Havre town was damaged numerous times during the historical period, by overflows from the tidal docks, during the events of 13-14 December 1981 (8.96 m), 30 January 1983 (8.95 m), 23-24 November 1984 (9.28 m). The tidal docks heights are at 9 m above the hydrographic zero reference (lowest tidal sea-level). We selected the tide-gauge records of the three flooding events. For each event, the surge height (the difference between the calculated and the observed tide) is determined and correlated with hourly wind and air pressure data from Le Havre meteorological station to determine the precise atmospheric and oceanographic conditions conducting to an overflow.

The flooding event of December 1981 was characterized by a slow decrease of the atmospheric pressure (from 1012 to 980 hPa) during 24 hours creating a surge of 0.97 m two hours before the high tide (HSL : 8.09 m). This conducts to an overflow when sea-level has reached 8.96 m at the moment of the high tide. The 30th January 1983, West to North-West winds (39 knots) occurred during 18 hours creating a surge of 0.83 m at the high tide (HSL: 8.12m). November 1984 was characterized by a fast decrease of the atmospheric pressure (from 1000 to 987 hPa in 8 hours) with South-West winds (30 knots) creating a water surge of 1.40 m during flow current. At the high tide (HSL: 7.95 m), winds force increased up to 47 knots and wind trends change from South-West to West creating a second peak surge of 1.30 m that has increased the duration of the high tide for 3 hours. Then a sea-level of 9.28 m was recorded. The three floods occurred under various conditions, with (1) a large atmospheric depression in 1981, (2) strong NW winds in 1983, (3) a combination of air pressure decrease and strong SW winds in 1984.

If surges are coupling with a high sea-level of a spring tide, overflow condition can occurred. The maximum astronomical tide is estimated at 8.40 m at Le Havre. Considering a surge of 2 m max, we can estimate a potential maximum sea-level at 10.40 m.

High-resolution mapping techniques, such as Light Detection and Ranging technology (LiDAR) can precisely identify and quantify morphological changes in coastal areas. LiDAR data acquired in 2006 and 2008 are used to build digital elevation models (DEM) and digital terrain models (DTM) of very high precision (30 cm). DEM are used to evaluate precisely historical and potential flooded areas in the town.

We use tidal records to observe sea-level variations in the tidal docks of the town on the historical period. A statistical analysis by linear regression of hourly tide measurements indicates a mean sea-level elevation of 1.75 mm/year since 1938. Results are in agreement with the sea-level rise (1-3 mm/year) recorded at the scale of the English Channel since 6 kyr. Sea-level rise predictions need to be integrated in the future scenario of overflows in the town.