
This paper focuses on the spatial coexistence between different hazards (strong west winds, beach sedimentary crisis and flash floods) in outlets of small catchments in a sedimentary basin. This study was carried out in the department of Upper Normandy located in north-western France. To anticipate possible future hazards and damages without depending on meteorological triggers (neither intense rainfall nor synoptic conditions), we combine previous knowledge accumulated on local phenomena to highlight the pre-conditioning factors and identify those areas characterised by the highest susceptibility to risk due to the accumulation of numerous hazards. This approach enables both space and time distribution patterns of natural hazards to be revealed. In space, the risk susceptibility strongly depends on morphology. Populations located at the outlet of large wet valleys, at the final outlets of small basins at a short distance from the plateaus and on the coastal fringe appear to be the most endangered. Even if hazards never occur at the same time, these areas can be affected by different hazards during one year (summer flash floods, floods, winter storm surges). This study identifies 14 sensitive areas along hollow shapes of the study area. Finally, our methodological investigations question the creation of a warning system combining mainland and marine hazards in these 14 outlets.

KEY WORDS: Natural hazards, Spatial interactions, Parisian Basin, France.

INTRODUCTION

Both the mainland and coastal parts of Upper Normandy (France) present a strong sensitivity to hydrological risks (fig. 1). Three reasons can explain this characteristic. Firstly, there is a close relationship between their morphology (hollow shape) and human occupation. In fact, urbanisation is preferentially located in the valleys and «vallenses» (i.e., dry valleys), which can be flooded but are the only link between the sea and inland. Secondly, this department is characterised by a sharp interface between land and sea. For example, cliffs frame the valleys over 50 m and the slopes of the valleys and their thalwegs are often steep. Thirdly, there is a strong spatial proximity between vulnerabilities and hazards (i.e., flash floods/coastal flooding) that occur over a very short time-duration (short time interval between the preparation of the phenomena leading to damage and the occurrence of risk). It should be recalled that these hazards (coastal flooding and mainland flooding, including flash floods) are among the most fatal phenomena in France (Costa, 1997; Delahaye, 2002; Douvinet & Delahaye, 2010). To improve knowledge on this topic, we combined various scientific data collected during previous field-experiments and research (Delahaye, 2002; Costa & alii, 2004; Douvinet, 2008; Letortu, 2010). This paper presents the different features of the hazards that are concentrated in the hollow shapes of the study area. By studying past phenomena, their spatial distribution can be better understood and some solutions for the management of hydrological risks can be provided.

STUDY AREA

The department (i.e., administrative sub-division in France) of Upper Normandy corresponds geologically to the north-western termination of the Parisian Basin. The plateau of Upper Normandy and its cliffs are formed by Cretaceous (Cenomanian to Campanian) chalk and are more or less resistant to weathering. Residual formations