FOCUS

EARTH SYSTEM – ENVIRONMENTAL SCIENCES SERIES

Management of the Effects of Coastal Storms

Policy, Scientific and Historical Perspectives

Philippe Quevauviller, Paolo Ciavola and Emmanuel Garnier

ISTE

WILEY

Management of the Effects of Coastal Storms

FOCUS SERIES

Series Editor André Mariotti

Management of the Effects of Coastal Storms

Policy, Scientific and Historical Perspectives

Philippe Quevauviller
Paolo Ciavola
Emmanuel Garnier

ISTE

WILEY

First published 2017 in Great Britain and the United States by ISTE Ltd and John Wiley & Sons, Inc.

ISTE Ltd
27-37 St George's Road
London SW19 4EU
UK

www.iste.co.uk

John Wiley & Sons, Inc.
111 River Street
Hoboken, NJ 07030
USA

www.wiley.com

Library of Congress Control Number: 2016961109

British Library Cataloguing-in-Publication Data
A CIP record for this book is available from the British Library
ISSN 2051-2481 (Print)
ISSN 2051-249X (Online)
ISBN 978-1-84821-762-1

Cover photo: New Brighton (UK) by Sally Priest

Contents

Preface

During the night of February 28th, 2010, the French Atlantic coastline was struck by a particularly violent storm, associated with a sea surge, which caused the death of 47 people. The flooded zones where the victims were most numerous corresponded mainly territories urbanized during the last three decades. For the littoral's population, the civil protection and the policymakers, this was a total surprise and the catastrophe was presented like a completely new and thus unforeseeable phenomenon. However, neighbouring countries close to France had coped with several similar events, sometimes more disastrous still, within the last 50 years. An example is the famous "Great storm" of 1953 which caused the death of several thousands of people in Great Britain, Belgium, the Netherlands, Germany, and which had also struck the North of France, illustrating that in France the memory of these extreme events had apparently been lost.

The idea of this book has a direct link with the so-called Xynthia event mentioned above. It was indeed suggested by the first author whose parents had been hit by the storm in the small town of Boyardville (Oléron Island) and experienced confusion following the event concerning the way in which expertise was used to delineate areas where houses at risk were to be destroyed and links with current policies were far

from being well explained and understood by concerned citizens. The very same event triggered discussions at EU level regarding the consideration of storm surges in the context of the EU Flood Directive and Integrated Coastal Zone Management related measures. It also encouraged the EU to design research topics in the 7th Framework Programme on Research and Development to better understand the mechanisms of such disaster-prone events and to provide an improved knowledge base supporting existing and developing policies.

One of these projects was the so-called MICORE project (Morphological Impacts and COastal Risks induced by Extreme storm events) which aimed to develop a prototype Early Warning System (EWS) for predicting coastal storm risk. This paved the way for the currently running RISC-KIT project (Resilience-Increasing Strategies for Coasts – Toolkit) which aims to develop methods, tools and management approaches with links to EU and national policies, and which takes the historical dimension into consideration.

This book therefore starts by discussing the current regulatory framework related to coastal storms and flooding, with considerations about the need to develop a "culture of risks". It includes international and EU policies in the area of natural disaster reduction, civil protection and adaptation to climate change. Chapter 1 written by Philippe Quevauviller also discusses the need for better communication of scientific knowledge and policies, with an accent on interactions among different actors and implementation needs.

The second chapter focuses on the technical and scientific aspects related to the assessment of coastal storm risks. It is built on Paolo Ciavola's experience in the coordination of the above-mentioned MICORE project and his involvement in the RISC-KIT project, leading the construction of storm impact databases in cooperation with Emmanuel Garnier, the author to the third chapter. The author provides a synthesis

of gathered knowledge on the evaluation of coastal vulnerability, including mapping and modeling, and a summary of recommended disaster risk reduction measures.

Finally, the historical knowledge dimension is fully developed in Chapter 3 written by Emmanuel Garnier. It focuses on understanding the mechanisms which may explain the magnitude of the Xynthia disaster occurring in a developed country and important member of the European Union. In particular the chapter focused on the example of the coastal town of La Faute-sur-Mer where 29 people of the same district drowned in the night. For this purpose, the chapter discusses the trajectory of vulnerability followed from the 18th century until 2010, with the objective of showing how a lesson learned, extracted from historical documentation, could have reduced this vulnerability considerably, like it has already done in certain countries of Northern Europe.

The book is aimed to address a wide readership covering the policy-making community, scientists and academia, practitioners as well as regional and coastal city authorities. It is hoped that the language will also be accessible to provide background information to citizens.

Philippe QUEVAUVILLER
Paolo CIAVOLA
Emmanuel GARNIER
January 2017

1

Coastal Storms and Flooding: Regulatory Framework and Science–Policy Interactions

1.1. Introduction

Coastal storms and flooding are areas of increasing concern, owing to growing urbanization and the related increased vulnerability to extreme climate events [IPC 14]. The increasing exposition of populations to such hazards leads to challenges linked to the development and implementation of regulations and management practices which take into account the adaptation to climate change. Actions related to improved risk prevention and reduction of climate-related hazards are embedded nowadays into international, European Union and national regulations and related management frameworks. In the case of coastal zones, however, although the prevention of hydrometeorological hazards is recognized as a priority at national level in many countries, the precise definition of these risks and hence their relations with the existing policy framework remains unclear [LAR 15]. The identification of coastal hazards (mainly storms and floods) concerns several

Considerations expressed in this book represent the sole views of the authors and do not reflect the formal position of any EU institution

Management of the Effects of Coastal Storms: Policy, Scientific and Historical Perspectives, First Edition. Philippe Quevauviller, Paolo Ciavola and Emmanuel Garnier.

domains other than the environment; in particular, urbanism, forestry, the insurance sector, tourism and civil protection, which are addressed by different types of regulations and codes of practice. This fragmentation is reflected from the EU to the national/regional levels. In addition, coastal risks are not subject to specific regulations despite being often mentioned, e.g. in research projects (see section 1.5) and texts related to territorial management plans.

Natural hazards in coastal zones can be separated into different types of risks [CAN 14], either of marine origin, e.g. submersion/flooding, storms, erosion, tsunamis, waves due to tornados, or of geological nature, e.g. land subsidence, earthquakes, landslides. In the context of this book, the focus will essentially be on coastal storms and flooding related to marine submersions, which may result from a combination of different phenomena such as wind, waves, high tide coefficients, low atmospheric pressures (leading to an elevation of the marine level) and abundant rainfalls. Marine submersions are considered as cumulative phenomena leading to either (or both) rapid or progressive flooding. The case of the Xynthia storm, which occurred along the West coast of France in February 2010, deals with both cases, i.e. a flash flood in the North (La Faute-sur-Mer) and progressive flooding in the South (Oleron island, Fouras, etc.). In each case, such submersion may lead to displacement of populations, significant modifications of land occupations and uses, losses of land as well as various environmental perturbations in wetlands and lagoons with modifications of the local ecosystems (e.g. salinization of freshwater resources and disappearance of beaches). Socio-economic and environmental impacts related to natural hazards in coastal zones, and notably coastal flooding, are therefore highly significant and subject to many controversial debates and studies. In reference to Xynthia, consequences of this storm generated many enquiries,

scientific studies, historical research, etc., which all pointed out limitations of knowledge about coastal risks and their social nature. Adversely, policymakers and politicians did not express themselves very much at all, despite media controversies flourishing in relation to inadequacies of the regulatory framework. Chapter 3 refers to this specific case which is also described in details (in French) in the literature [GAR 13, LAR 15]. The present chapter provides a general background about the existing regulatory and EU-funded scientific framework and discusses difficulties in establishing interactions among the scientific and policy-making communities.

According to IPCC [BAT 08], observational records and climate projections provide abundant evidence that observed warming over several decades has been linked to changes in the large-scale hydrological cycle (e.g. effects on atmospheric water vapor content and changes of precipitation patterns with consequences on extreme floods and droughts). The consequences of climate change, in particular the increased frequency and severity of extreme hydrometeorological events, may alter the reliability of current water management systems. While quantitative projections of changes in precipitation, river flows and water levels at the river-basin scale remain uncertain, it is very likely that hydro(meteo)logical characteristics will change in the future. These considerations lead to the development of a complex policy framework which plans adaptation and mitigation options to tackle impacts of global warming on water resources and risks to society and assets. These options are closely linked to a range of policies. This chapter gives an outline of some policies relevant to hydrometeorological events, with no pretention of exhaustiveness. Some considerations have been adapted from previous publications [QUE 11a, QUE 11b, QUE 14].

1.2. Natural hazards and risks in coastal zones: needs to build-up a "culture of risks"

1.2.1. *Introduction*

Coastal zones were unoccupied for centuries as they were considered as dangerous areas by populations. This has changed only recently with the establishment of populations along coastlines, increasing their exposure to natural hazards (e.g. flash floods, seismic risks associated with tsunamis, marine submersions and erosion). Nowadays the littoral zone is very much in-demand and is confronted with a growing demography. The United Nations even estimates that, at the 2020 horizon, around 80% of the world population will live in a territorial stretch less than 100 km from the sea. As a result, natural hazards in coastal areas will increasingly threaten human societies, their assets and activities. These threats will be exacerbated by climate change which has an influence not only the sea-level rise but also on rainfall regimes and storm severity [LAR 15]. In less than 20 years, the awareness about climate-related risks has led to a huge development of research activities (see section 1.5).

A natural risk is generated by the conjunction of a threatening phenomenon which is identified as a hazard, and related human challenges characterized by their vulnerability to this hazard. In a way, human societies' awareness of natural hazards has certainly played a major role in the development of environmental policies, originally aimed toward the prevention of disasters rather than the protection of the environment itself. This policy sector has hence led to establishing founding principles of what may be referred to as a "culture of risks", which is being developed at policy level as well as in the collective consciousness [LAR 15].

In parallel, coastal zones present the paticularity of gathering several environmental compartments, which generates legal discussions that are reflected in specific environmental policies, with the risk of fragmentation. Considering the diversity of natural hazards, their intensity and potential impacts which may vary from region to region, the regulatory framework and its implementation may have different socio-economic and environmental dimensions, and the specific regulations have to be properly coordinated in order to manage the risks efficiently.

1.2.2. *Contribution of environmental policy to the development of a "culture of risks"*

According to Michelot in [LAR 15], the "culture of risk" can be defined as "the ensemble of perceptions and behaviours adopted by a society facing risks". It is associated with the society's memory about risks, i.e. a system of maintenance of the legacy of knowledge from the past and its consideration for reduction of today's vulnerability. This presents the idea of highlighting the need to better understand hazards and their impacts, and of developing the information, the education and the memory of risks. In a sense, developing a "culture of risks" is closely related to a democratic decision-making process on both an individual and collective scale. Every citizen should have the possibility to freely access information about the risks to which he/she is exposed as well as objective information on what is done to protect his/her security. The Civil Society, enterprises and representatives of national authorities should also be in the position to respond to citizen's expectations regarding their security.

This awareness carries greater significant nowadays with the increased frequency of natural hazards, some of them leading to disasters. This risk awareness is, however, not new. In the marine sector, the risks for navigation were well

identified and related to dangers that were not linked to human actions [EWA 86]. Until the 19th Century, the notion of risk was linked to natural events. This changed with the industrial revolution, which led us to consider human activities as generating risks as well which had to be understood, managed and even anticipated [LAR 15].

Before speaking about environmental policies and their links to the "culture of risks" for coastal areas, it is useful to recall the role of policies in the establishment of this culture of risks. In a sense, we might argue that policies should include risk components and related objectives. This is the principle followed more largely by the DPSIR approach (Driver-Pressure-State-Impact-Response), which includes the notion of risks and responsibilities regarding the "responses" to address them. Environmental policies have the peculiarity of repositioning the relationship with risks in a holistic manner. In other words, many different branches of policies are mobilized in a given area to identify, assess and more generally manage risks or the related responsibilities. An example of integrated policy is the EU Water Framework Directive, which follows the above mentioned DPSIR principle, starting from risk assessment and mapping, to monitoring responsive actions to meet well-defined objectives [QUE 11a]. An important aspect which is not easy to tackle is the way society handles risks in the light of a policy framework, which is often far from people's direct prerogatives. This embeds not only risks for the environment, but concerns policies related to working rights, consumer rights and health as well which all have to be taken into consideration regarding risk management, in particular prevention.

Environmental policies may be a useful way to better frame the question of risk. Indeed, the above-mentioned DPSIR approach readily addresses risks and their impacts, taking societal (and economic) impacts into account at