Blue Book One

Mapping Flooding and Flood Prevention
in the Baltic Sea Region

Editors' Letter

This Notebook is one of nine in the Fourteen Point Three Notebooks collection brought together by the European Union Strategy for the Baltic Sea Region flagship project 14.3 (read: fourteen point three).

Eight Notebooks will present you with findings from our project's four different working groups (named Task Groups C, D, E and F), and one Notebook will introduce a general overview of the whole project.

We hope that the collection as a whole will give you a sense of the unfolding diversity and complexity of the project, whilst retaining homogeneity as a single vision and ideal. The singular Notebooks present concrete results (studies, workshop reports, developed methodologies and scenarios). The structure of the entire collection intends to act as a mirror for the project as a whole, and to reflect on the process as much as the output. Each of the books can be read singularly as a study presenting concrete findings from working groups, at the same time they can be read as a collection. Manifested together we view this as the symbolic added value brought to the macro-regional conversation by the project 14.3.

These values could be: the network, the will for cooperation in general terms, the challenges in finding a uniform language among different civil protection cultures and traditions, and the motivation to find commonality amongst the different departure points.

Blue Book One and Two bring you the body of the Task D work. Within this task, a group of experts and prevention practitioners from six Baltic Sea region countries sat down together to jointly discuss prevention of one hazard which by now, is common or very likely to every country in our region, namely – flooding. Flooding has long been one of the more common risks for most of our countries, and thus each one has developed a variety of individual ways to deal with it. However, regardless of our geographic proximity and landscape/climate similarity, specific and different types of flooding which have occurred in each country in the region were treated separately. Expert conversation has now shifted to highlight that with flooding appearing more regularly and consequences developing more rapidly in the region, the time has come to bring this segmented knowledge together.

Task D experts delivered an extensive State-of-the-Art study, which for the purpose of the Fourteen Point Three Notebooks was split in two parts. Blue Book One provides the reader with a basic flooding cartography of the Baltic Sea region, drawn from examples of the six studied countries. This introductory overview in Blue Book One becomes a backdrop against which the important outline of current flood prevention priorities is laid out, as well as the springboard from which a more comprehensive vision can be reached.

Together with Blue Book Two which highlights the input of project 14.3 into the overall discourse of flood prevention in the region, both books form a solid basis on which the body of joint macro-regional flood prevention practice in the Baltic Sea region may be build.

It is our pleasure and honour to be sharing with you a vision of cooperation through our Blue Books in particular, and the Fourteen Point Three Notebooks in general.

Editors of Fourteen Point Three Notebooks
Egle Obcarskaite – Anthony Jay Olsson

Summary of the Project

14.3 was a project implemented under the EU Strategy for the Baltic Sea Region (EUSBSR), Priority Area Secure (Priority Area 14 in the 2009 version of the EUSBSR Action Plan). The whole priority area calls for an insurance that contributions in the field of civil protection encompass the overall Strategy objectives (save the sea, connect the region, increase prosperity). The project 14.3 responds specifically to the objectives through addressing the necessities of bringing together and coordinating civil protection stakeholders and bolstering the capacity of individual countries, in order to ensure our region's uniform resilience to macro-regional risks.

14.3 was developed from a belief that considering the nature of the world that we live in today, only by ensuring a proper level of resilience on a macro-regional level can we ensure a higher level of resilience and preparedness on the national level as well.

Project 14.3 was a pioneering effort.

Not only for addressing the topic of macro-regional risk in the Baltic Sea region (before this project there wasn't even a common concept discussed among the countries in the region), or for bringing up a complex all-hazards approach, but also for bringing together a partnership consisting of all countries in the region, to not only discuss and share but develop together a strategic approach to civil protection. As such, it thus constitutes a shift in the whole paradigm of the way civil protection may be conceived on a macro-regional level.

Why it is only now that 14.3 could have happened?

Some say because there was previously never this level of openness in sharing information on civil protection tools and methods among different countries in the region; this could not have been imagined twenty or even five years ago. Others say it was because countries in our region finally openly recognized their individual vulnerability, as well as the fact that there may be situations to which even the most resourced country would face the need to ask for assistance from a neighbour. 14.3 partners came together admitting it straight: it is not enough to ask – you have to be ready to receive assistance.

Pioneering efforts also meant that 14.3 was a daring effort.

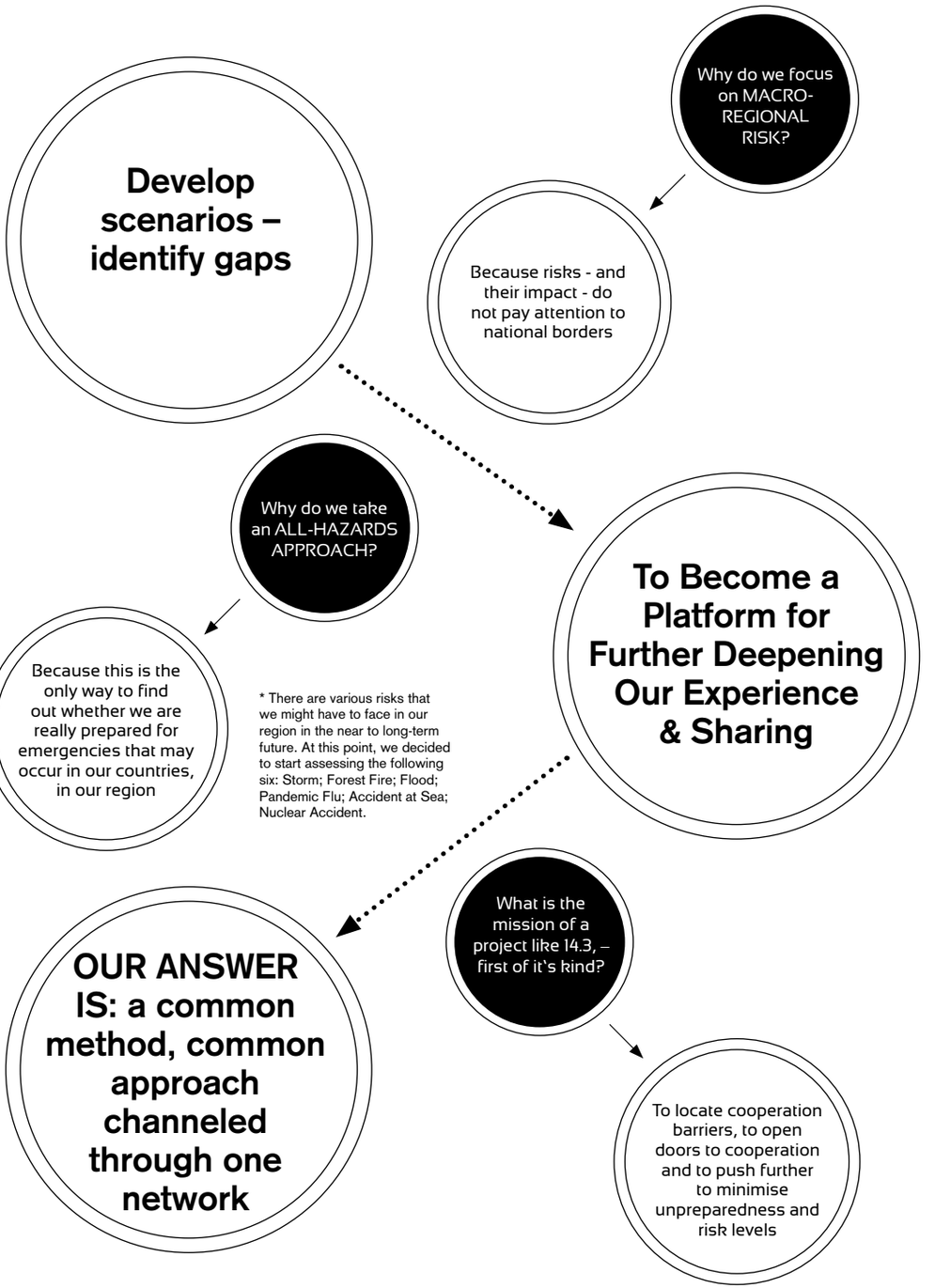
This was especially visible in how the all-hazards approach had to be adopted for the project. All-hazards approach is a challenging claim even on national level, as it requires crossing administrative and institutional boundaries. Which is the best way to achieve this? The answer is yet to be formulated.

Project 14.3 proposed to take one step at a time and responded to the all-hazards challenge through structuring the project in four thematic tasks. There were three tasks dealing with the following hazards: floods, forest fire and nuclear accident. Whereas one task – Task C – engaged in an overall strategic discussion on how can risk be assessed and analysed on a macro-regional level, and how a common risk-discourse can decrease societal vulnerability of each singular country in the Baltic Sea region, as well as that of the macro-region as a whole.

Working Together on Macro-Regional Risk.

Project 14.3

Was the First Time that the Countries Around the Baltic Sea Worked Together on Macro-Regional Risk*



Here are the types of questions we asked ourselves in workshops and expert groupings

Fourteen Point Three Notebooks

Collection of Fourteen Point Three Notebooks is Set to Launch a CIRCULAR LOOP in which ONE PART Manifests The Whole and THE WHOLE Manifests One Part →

Task C

Macro-Regional Risk

What will it take for us to have a common approach to risk and a common method to assess it? Do we need it? Why?

→ RED BOOK ONE / TWO →

Task D

Floods

How can we best share our experience in coping with floods? Could this help us to reduce the national costs associated with flood prevention, preparedness and response?

→ BLUE BOOK ONE / TWO →

Task E

Forest Fire

What fire risk models are used already in the Baltic Sea region? How can these be bolstered? What kind of common system would we need and why?

→ GREEN BOOK ONE / TWO →

Task F

Nuclear Accident

Would we be able to cope with a nuclear emergency which would impact several countries in the region? How can we create a common response and alertness mechanism?

→ ORANGE BOOK ONE / TWO →

... Red Books represent the contribution

from our Task C experts whose main concern centred on beginning a discussion on the risk-assessment challenges in the Baltic Sea Region; a discussion that, for the first time, would include all countries from the area. In their two Notebooks they bring to us an insight on how our countries meet the challenge of assessing overall risk. They also question and explain what methodology can be used together, and they bring us their first attempt to develop a common language by drawing six different risk scenarios.

... Blue Books represent the outcome

from the Task D Grouping who have discussed flood prevention practice in the Baltic Sea region. Floods are an annual occurrence for most of the countries in our region, and each one of them has developed a strong national know-how of coping with this type of emergency. However, the discussions focused on how can we increase the effectiveness of our actions in dealing with this emergency by sharing experiences of individual singular-country specific cases? The Blue Books give us a picture of various flood prevention experiences in the Baltic Sea region, as well as their conclusions and recommendations for further know-how sharing.

... The Green Books focus on our regions foliage,

vegetation and forest cover and what happens when fire occurs. As our Task E experts discovered, all countries that participated in the work of Task E have their own national fire risk systems. These systems are both, similar and different at the same time. The question asked of experts was whether the region needs to have one fire risk system for the whole region? What would that system entail and how would that system borrow elements from other systems already developed elsewhere? This is to be decided in the future. For now, we have made a first step in this process providing you with an overview of existing fire risk systems in the Baltic Sea region.

... Our Orange books investigate nuclear accidents

The nuclear question is probably one of those regional questions which we cannot afford to overlook in a macro-regional context judging by its potential impact. To show you why this is so, Task F experts developed a scenario for an hypothetical accident in Finland that may have severe consequences on other countries in the region. The second part of their task work was to assess this developed scenario and provide recommendations for further activities that would increase our preparedness towards accidents of this complex kind. The scenario and workshop report are both delivered to you in our Orange Books completing the circle.

The EUSBSR flagship project 14.3 was a novelty on various levels

Two of the most important ‘firsts’

...partnership of diverse
civil protection actors from every country of the Baltic Sea region was built

...the focus
of the project was concentrated on an all-hazards approach through a macro-regional lens

The questions we asked ourselves were

How can we acknowledge and communicate the project’s complexity, and capture it without reducing or subordinating it at the same time?

How can we talk about the methods and the substance of inquiry at once, whilst keeping both on an equal footing?

Blue Book One will briefly describe to you, how six countries in the Baltic Sea region are currently and may be further exposed in the future to the challenges of flooding, what are the gaps today in preparedness, as well as what are the priorities in the future in terms of flood prevention for the region. →

Task D Fact Sheet

18 Months of...

MEETING →

Tallinn → Riga → Warsaw

The task was led from Frederikssund, Denmark

WORKING together →

Frederikssund-Halsnæs Fire & Rescue Service (Denmark) – Estonian Rescue Board – Hamburg Fire Service Academy (Germany) –State Fire and Rescue Service of the Republic of Latvia – Main School for Fire and Rescue Service in Warsaw (Poland)

SHARING experiences →

(Core Group of Experts)
Kim Lintrup, Nanett Mathiesen, Amalie Møller Janniche (DK) – Robert Stacey (UK) - Kady Danilas, Kristi Tekko, Ivar Kaldasaun (EE) – Jürgen Krempin, Tim Sufin (DE) – Jevgenija Petuhova, Ivars Nakurts, Rūdolfs Āzens (LV) – Tomasz Zweglinski, Wiktor Gawronski (PL)

KIM LINTRUP Task D Leader:

“It did not take much for this project to bring added value that was not there before. It was enough to organize a few workshops and to write a state of the art study – by doing this we had already reached a new level of practical information exchange on floods that had not been reached in the Baltic Sea region before. This project provided us with a great opportunity to practically discuss a problem that especially concerns me as a Chief Fire Officer in Denmark, namely – flooding. This problem is not only relevant for the Baltic Sea region, it is a global one. Yet we have to start addressing it macro-regionally, for in all of our countries we have a lot of knowledge collected. It is very important to enable the sharing of this knowledge”

TASK D Gave Us

→ A detailed questionnaire to collect data on current flood prevention across the Baltic Sea region.
→ An overview on floods and flood prevention in six Baltic Sea region countries.
→ A list of specific identified gaps in flood prevention practice in six Baltic Sea region countries.
→ An overview of some future priorities in flood prevention in six Baltic Sea region countries.
→ Recommendations and a platform for further cooperation and knowledge exchange in the Baltic Sea region as a whole.

Flooding and Flood Prevention in the Baltic Sea Region: An Overview – Current Gaps and Future Steps Ahead

Introduction

Flooding has the potential to cause catastrophic damage and loss of life.

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According to the World Economic Forum's (WEF) 2011 Report titled "Global Risk Landscape", flooding is one of the top ten global risks by likelihood and impact combined (i.e. flooding has a high likelihood and high impact). Not surprisingly, flooding is a significant risk for the countries of the Baltic Sea region. Numerous events of flooding in the past have caused devastation, destruction and mass loss of life within the Baltic Sea region, some of which are described within this report. Some of these events affected isolated areas and countries while others have simultaneously affected multiple countries.

The purpose of this report, as it is presented in Blue Book One and Blue Book Two of the Fourteen Point Three Notebooks, is to provide a holistic overview of the flood prevention plans and strategies that are currently implemented within the Baltic Sea region.

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While many, if not all, of the countries in the region are already implementing very good risk assessment and prevention systems, one thing that is currently missing is a macro-regional approach to risk scenarios and prevention of potential hazards; including flooding. The Authors[1] of the report hope that it will serve as a useful foundation from which to commence further discussions on the issue of macro-regional cooperation in flood prevention in the Baltic Sea region.

1 Blue Book One and Blue Book Two provide material from the State of the Art Study delivered by the EUSBSR flagship project 14.3 Task D working group. The study has been written and compiled by Dr Robert Stacey (Northumberland Fire and Rescue Service, UK) and Kim Lintrup, Chief Fire Officer (Frederikssund-Halsnæs Fire and Rescue Service, Denmark)

List of Abbreviations and Acronyms

Abbreviation/ Acronym	Description
BOOS	Baltic Operational Oceanography System
CBSS	Council of the Baltic Sea States
DEMA	Danish Emergency Management Agency (Beredskabsstyrelsen in Danish)
EC	European Commission
EMHI	Estonian Meteorological and Hydrological Institute
EMS	Environmental Monitoring System
EUSBSR	European Union Strategy for the Baltic Sea Region
EWS	Early Warning System
FGE	Flussgebietseinheiten (English translation is "river basins")
FRMP	Flood Risk Management Plan
GIS	Geographic Information System
HIROMB	High Resolution Operational Model for the Baltic
IFRM	Integrated Flood Risk Management
IFRMP	Integrated Flood Risk Management Planning
ISOK	National Protection against Extraordinary Natural Hazards Project (Poland)
Km	Kilometres
M	Metres
MDMT	Multimedia Decision-Making Training
MIC	Monitoring and Information Centre
MSB	Myndigheten för samhällsskydd och beredskap (Swedish Civil Contingencies Agency)
NFRS	National Fire Fighting Rescue System (Poland)
PFRA	Preliminary Flood Risk Assessment
SEIA	Strategic Environmental Impact Assessment
SFS	National Rescue Coordination Centre (Poland)
SGSP	Main School of Fire Service (Poland)
SRSA	Swedish Rescue Service Agency
UFRM	Urban Flood Risk Management
WEF	World Economic Forum

Introducing Task D – Flood Prevention

The purpose of this report is to provide a holistic overview of the flood prevention plans and strategies that are currently implemented within the Baltic Sea region. This report is a deliverable of Task D (Flood Prevention) of the EUSBSR flagship project 14.3, and it is presented for the wider audience in two of the project publications: Blue Book One and Blue Book Two. The original State of the Art Study can be found on www.14point3.eu website, among Task D documents.

Task D aimed to:

AIM 1

To develop reference scenarios for floods, using risk assessment information, in order to promote a more rapid response and to identify current gaps.

AIM 2

To promote development of innovative methods and procedures as well the dissemination of experience and best practice flood prevention methods. This includes, for example, giving a more focused attention towards a comparison of flood plans, legal aspects and land use prevention methods, ice jam prevention methods and simulation methods, and the production of a kind of "check list" of typical problems.

AIM 2

To encourage the adoption of a common approach to flood management operations for civil protection teams and modules involved in bilateral or international operations, in the event of cross-border or large scale flooding disasters.

In order to achieve these three key aims, Task D Group collaboratively implemented and completed seven key actions:

Action D.1

To organise a Kick-Off Workshop in Tallinn, Estonia, 1-2 May 2012.

Action D.2

To compile a State of the Art Study on Flood Prevention in the Baltic Sea Region.

Action D.3 and Action D.4

To organise a Workshop on the topic of "Land-Use and Legal Aspects of Flood Prevention" in Riga, Latvia, 21 November 2012; and organise a Workshop on the topic of "Methodologies used to deal with Ice-Jams in Rivers" in Riga, Latvia, 22 November 2012

Action D.5 and Action D.6

To organise a Workshop on the topic of "Flood Simulation Software" in Warsaw, Poland, 9 April 2013; and organise a Final Meeting to conclude the final results of Task D in Warsaw, Poland, 10 April 2013.

Action D.7

To incorporate the final results of Task D into the Final Report of the EUSBSR flagship project 14.3.

First Steps: Task D Data Collection Methodology

This chapter explains the methodology that was developed and implemented in order to collect data for this report. The chapter begins by explaining different flood-related definitions that have been adopted for use by the Task D partners. The chapter then concludes with an explanation of the development and circulation of a standard data collection questionnaire to different authorities within the Baltic Sea region.

Defining and Classifying Floods

During the early stages of the project, partners working on all four tasks within the EUSBSR flagship project 14.3 identified that

> whilst each country in the region already has well developed natural hazard risk assessment and prevention systems, different countries currently use different terminology and concepts and that this can create barriers to the effective exchange of information and ideas.

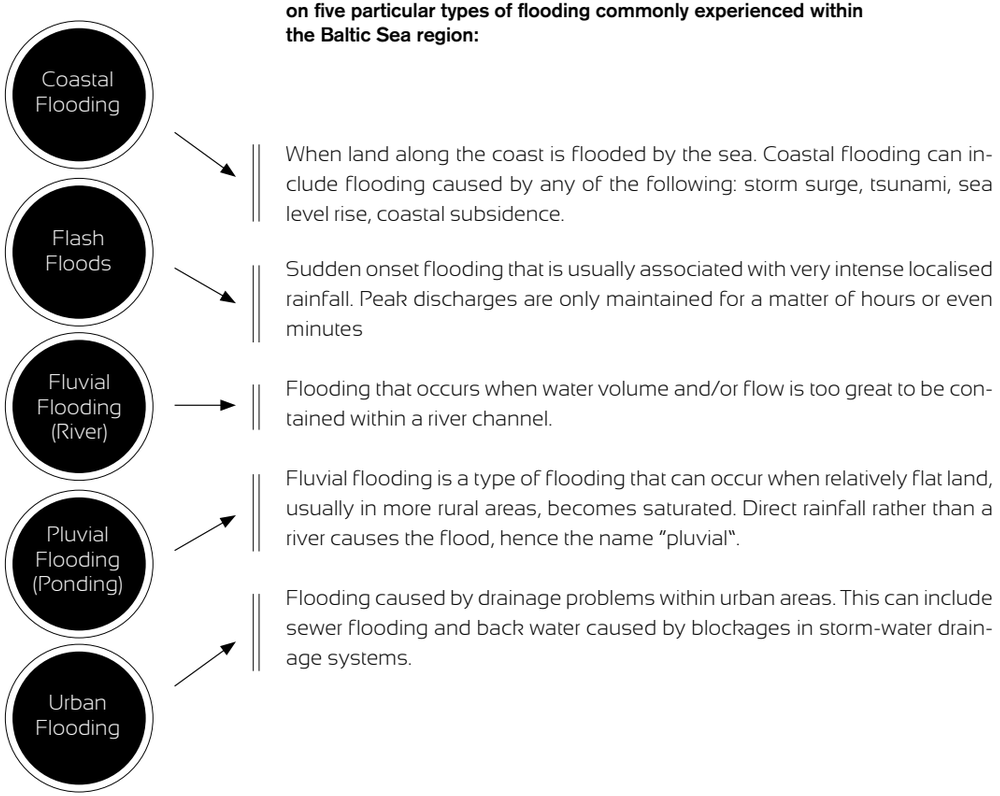
It was therefore decided by the partners working on Task D to commence the project by establishing a **common language**.

The first concept that the Task D partners reviewed was the concept of what constitutes ´flooding´ itself. For the purposes of this report and Task D the following definition of ´flooding´ has been adopted:

> 'Flooding' or "´flood´ means the temporary covering by water of land not normally covered by water."
> (Article 2 of the EU Floods Directive, 2007/60/EC) [2]

2 Available at: http://floods.jrc.ec.europa.eu/eu-floods-directive.html

Task D partners also decided to concentrate actions and discussions on five particular types of flooding commonly experienced within the Baltic Sea region:



Task D Questionnaire

During the Kick-Off Meeting for Task D, partners collaboratively developed a detailed questionnaire to collect data on flood prevention across the Baltic Sea region. The questionnaire was circulated to all Task D partners and a number of organisations with a responsibility for flood prevention within the region.

The questionnaire requested that respondents provide some general context regarding flooding within their country/region. Respondents were then asked a series of questions designed to gather information about short- and long-term flood prevention measures that are currently implemented. The penultimate two sections of the questionnaire requested respondents to provide information about future flood prevention activities and any gaps that have been identified in current flood prevention practices and policies. In addition, all respondents were requested to provide contextual information about a recent large flooding event within their country to form the basis of an illustrative case study.[3]

A total of six questionnaires were completed and submitted. The authors would like to thank all of the individuals and organisations that completed and submitted copies of the questionnaire.

Additional notes on terminology used within the report

The three terms of "dyke", "levee" and "embankment" have been used interchangeably throughout this report to describe: elongated naturally-occurring ridges or artificially constructed ridges or walls which regulate water levels. Levees, dykes and embankments are commonly found on river flood plains running parallel to the course of a river or along low-lying coastal areas.

The project team decided that the interchangeable use of these three terms should not cause confusion because all three are commonly used in both popular and technical discourse. This definition would also cover the terms levée dike, floodbank or stopbank.

3 The case studies are provided in Blue Book Two


Baltic Sea Region
Profile in Flood
Prevention

An important precursor to developing a macro-regional approach to flood prevention is the need to first understand the similarities and contrasts that exist within the individual countries that the region is comprised of.

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The geographical, social and climatic characteristics of the Baltic Sea region countries have a significant impact on the frequency and types of flooding that are experienced. This in turn influences innovation and the implementation of flood prevention measures. The purpose of this chapter is therefore to provide some basic facts and statistics regarding the human and physical landscapes of the countries and regions studied within this report (including: Denmark, Estonia, Germany (Hamburg, Mecklenburg-Vorpommern and Schleswig-Holstein), Latvia, Poland and Sweden) and to provide a suitable foundation from which to present case studies of specific flooding incidents and current flood prevention measures[4].

The Baltic Sea is a body of brackish inland water which is approximately 1,600 km (1,000 miles) long and an average of 193 km (120 miles) wide. The Baltic Sea region is a collection of countries positioned around the Baltic Sea and which have a shared history and geography that is intricately linked through the Baltic Sea. In most circumstances, the term Baltic Sea region is used to describe the countries that are found within the Baltic Sea Drainage Basin[5].

In terms of political and cross-border operational cooperation, there are a few other definitions of what territories constitute the Baltic Sea region.

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The Council of the Baltic Sea States (CBSS) membership maps the region through its eleven Member States: Denmark, Estonia, Finland, Germany, Iceland, Latvia, Lithuania, Norway, Poland, Russia, Sweden (Figure 1). The European Union is also a Member.

4 Both case studies and an overview of current flood prevention measures are presented in Blue Book Two.

5 The Baltic Sea region Drainage Basin is the area of land that is drained through various river networks into the Baltic Sea. The BSR Drainage Basin actually comprises a collection of numerous smaller drainage basins. Some of the major drainage basins that form the BSR Drainage Basin include: Bothnian Bay, Bothnian Sea, Gulf of Finland, Gulf of Riga, Baltic Proper, Danish Straits and Kattegat.

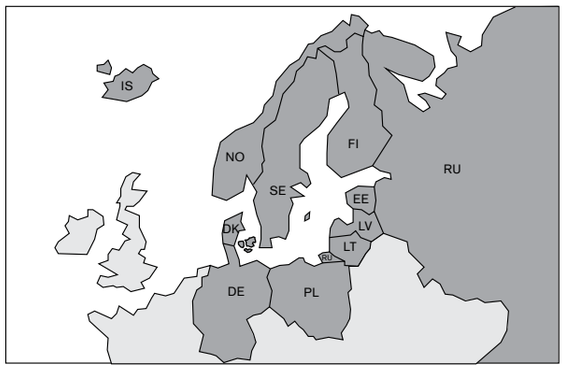


Figure 1 Map of the Council of the Baltic Sea States (CBSS) Member States

The European Union Strategy for the Baltic Sea Region (EUSBSR), the first macro-regional strategy of the EU, defines the Baltic Sea region primarily through the EU Member States that are situated around the Baltic Sea. Therefore, the EU Baltic Sea Macro-Region, is constituted by eight countries: Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland and Sweden. However, the recently revised EUSBSR Action Plan (February 2013 version) introduces, an emphasis on cooperation activities between the EU Baltic Sea Macro-Region countries and its neighbours, Russia in particular.

Other initiatives and players in the region provide similar definitions. As an example, the Baltic Development Forum (BDF) Annual State of the Region Report defines the Baltic Sea Region as including the Baltic countries Estonia, Latvia and Lithuania, the Nordic countries of Denmark, Finland, Iceland, Norway and Sweden, Northern Germany (Hansestadt Hamburg, Mecklenburg-Vorpommern and Schleswig-Holstein), Northern Poland (Pomorskie, Warminsko-Mazurskie and Zachodnio-Pomorskie), and Russia's Northwestern region including Kaliningrad.

EUSBSR flagship project 14.3 partnership most closely resembled the Baltic Sea region map as it is drawn by the CBSS and its Civil Protection Network[7]. As this study is prepared within the framework of the project, it will refer to the Baltic Sea region as a region defined by the CBSS political map.

7 The only CBSS Member State that did not participate in the 14.3 project was Iceland; their participation, however, is foreseen in the follow-up project to the 14.3.

Task D Mapping: Six Baltic Sea Region Country Profiles[8]

Just as the countries of the region share common economic and political interests, they also share common geographies and common problems in the form of natural hazards. For example, Figure 2 illustrates how numerous large rivers flow through multiple countries within the Baltic Sea region, creating common flood risks.

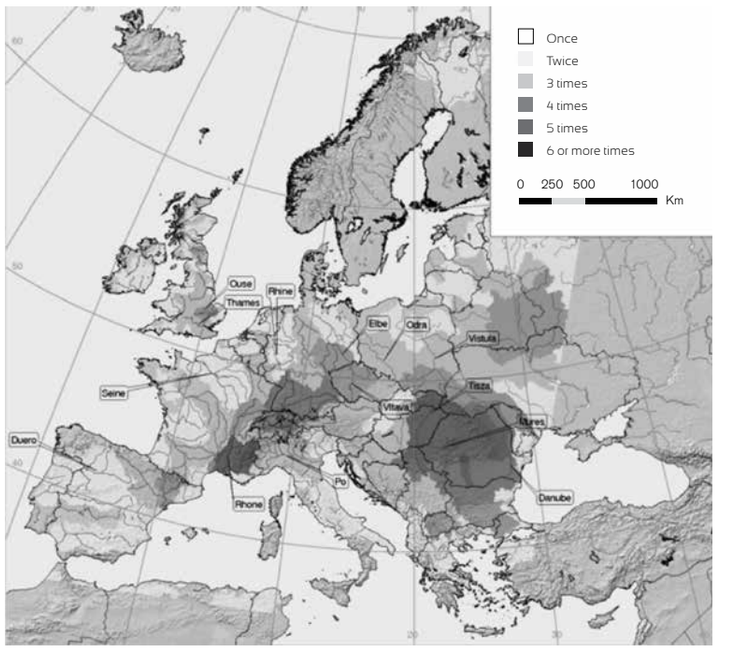


Figure 2 River Catchment Flooding in Europe (1998-2005)

8 While the overall partnership of the EUSBSR flagship project 14.3 included ten Baltic Sea region countries, only six of them participated in the Core Group of the project Task D. For this reason, the cases and analysis provided in Blue Book One and Blue Book Two are drawn based on experience stemming from countries that participated in the Task Core Group (Denmark, Estonia, Germany, Latvia, Poland and Sweden).

For the purpose of basic comparison, Table 1 provides some basic comparative statistics regarding the population and land areas of the CBSS Member States/Federal States (Germany) that are included within the scope of this study. The following sections of this chapter then present summary descriptions of the human and physical landscapes and the current experiences of flooding within these selected Member States/Federal States (Germany).

Table 1 **Population and Land Area Statistics for Baltic Sea region Countries within the Study and regions**

Country/State	Population	Land Area
Denmark	5.6 million	42,800 km^2
Estonia	1.3 million	45,200 km^2
Hamburg (Germany)	1.8 million	755 km^2
Mecklenburg-Vorpommern (Germany)	1.6 million	23,191 km^2
Schleswig-Holstein (Germany)	2.8 million	15,799 km^2
Latvia	2.1 million	64,500 km^2
Poland	38.5 million	312,000 km^2
Sweden	9.6 million	407,340 km^2

DENMARK

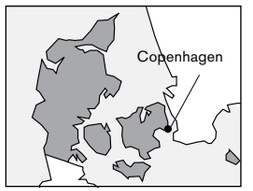


Figure 3

Map of Denmark

Summary description

has a population of 5.6 million people living on a total land area of approximately 43,000 square kilometres. The country is situated on the western edge of the Baltic Sea region and consists of the Jutland peninsula and 443 named islands which form the Danish archipelago. The ten largest islands in Denmark are (in decreasing size): Zealand (Sjælland), North Jutlandic Island (Nordjylland), Funen, Lolland, Bornholm, Falster, Mors, Als, Langeland and Mon. The capital city of Denmark, Copenhagen (Kobenhavn in Danish), is situated on the island of Zealand.

is relatively flat and low-lying: the highest natural point, situated on the Jutland peninsula and called Møllehøj, is just 171 metres above sea level while the lowest point (which is also the lowest point in Northern Europe), Lammefjord, is situated 7m below sea level.

It's geographic position is quite unique in that its lengthy coastline (7,314 km) borders both the Baltic and North Seas. The River Guden is the longest river in Denmark at 176km long and has a catchment area of 2,643 km^2. However, the largest river in Denmark according to volume is the River Skjern which drains approximately one tenth of the whole country.

River systems and river flooding

The most common type of flooding experienced in Denmark is river flooding, although coastal flooding and urban flooding also causes infrequent problems. A recent example of a typical river flood was experienced in 2007 when Usserød Å flooded housing areas in the town of Kokkedal after 167 mm of rain fell in just 24 hours. The dykes protecting the town were breached causing a major emergency which saw homes abandoned and the deployment of the Danish Home Guard.

One of the main causes of river flooding in Denmark is inadequate maintenance and clearance of rivers and streams by local administrations. This leads to the build-up of debris which restricts water flow. Water builds up behind the debris which usually following periods of heavy rainfall cause obstacles which force the river to breach its banks which in turn floods the surrounding area.

Coastline and coastal flooding

While less frequent than river flooding, coastal flooding is still of concern in Denmark. The coastline of Denmark is populated by a large number of fjords, especially along the eastern coast of Jutland and the northern coast of Zealand. Approximately 15% of the total coastline of Denmark is protected by dykes. These dykes are mostly located along the coastline of Jutland, however, the threat from coastal flooding has been experienced in other areas of Denmark that are not as well defended by dykes. Denmark's unique position bordering both the Baltic and North Seas means that water can push and rise against the coastline from both directions. When storms approach Denmark from a northerly direction they push water from Kattegat Bay (between Jutland and Sweden) and the Baltic Sea into the fjords, commonly causing flooding on the islands of Funen, Lolland and Falster. An example of one of these events occurred during the storm of the 1st November 2006 when several towns on Funen reported flooding of housing areas, ports and roads.

Urban flooding

The other type of flooding infrequently experienced in Denmark is urban flooding. One of the most recent serious incidents of urban flooding occurred on 2nd July 2011 in Copenhagen when a significant amount of rain fell over a very short period of time. The city's drainage system could not cope with the volume of water and water levels rose in the streets to a level of about 50cm. For two days following the initial flood the freeways in and out of the city were impassable to traffic. Further information concerning this flood can be found in Blue Book Two.

ESTONIA

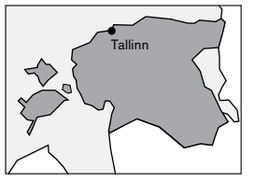


Figure 4

Map of Estonia

Summary description

has a population of approximately 1.3 million people living on a land area of approximately 45,200 km^2. Estonia is one of the least populated states within the European Union and is situated on the eastern edge of the Baltic Sea region, sharing land borders with Russia and Latvia. The country has a long coastline (1,393km) which is populated with approximately 1,500 islands, the two largest of which are Saaremaa (2,673 km^2) and Hiiumaa (989 km^2).

is relatively flat and low-lying: the average highest natural point is Suur Munamägi (Egg Mountain) at 318 m above sea level. The country is covered in 18,000 km^2 of forest, which accounts for approximately 50% of the total land area. There are also 7,000 fens, bogs and swamps in Estonia which cover approximately 22% of the territory.

River systems and river flooding

Estonia has a very dense network of rivers (approximately 7000 rivers with a total combined length of 31,000 km). Most rivers are very short with small catchment areas. There are just 10 rivers which are over 100 km in length. The longest river is the Võhandu River at 162 km, followed by the Pärnu River at 144 km. These rivers are then followed in length by the Põltsamaa, Pedja, Kasari, Keila, and Jägala Rivers. The two largest catchment areas in Estonia are the Narva and Emajõgi river basins. The Narva River catchment area is 56,200 km^2 and is larger than the total territory of Estonia because it also drains part of western Russia. The Emajõgi basin is located almost entirely within Estonia and drains 22% of the total land area (9,740 km^2).

The melting of snow and ice in the Spring and the associated rises in river levels is a common and frequent cause of flooding in Estonia. Spring high waters are particularly extreme when there has been late thawing and melting of the winter snow and ice which has been accelerated by rainfall. The Spring high waters begin mostly in March and reach their peak in April every year. They often cause flooding of undeveloped land but sometimes flood towns and cities. The last severe spring flood occurred in the Spring of 2010.

Coastline and coastal flooding

Estonia's low-lying coastline makes it vulnerable to coastal flooding, particularly during the passage of low pressure storms (cyclones). The last severe incident of coastal flooding occurred in January 2005 in western Estonia. During this storm, significant flooding was experienced in Pärnu, Estonia's second largest city.

Urban flooding

Other types of flooding that infrequently occur in Estonia are pluvial (ponding) and urban flooding. Pluvial flooding sometimes occurs during the spring high water periods when the relief combined with insufficient drainage within rural areas causes the formation of temporary water bodies or ponds. In terms of urban flooding, the most recent incident occurred in August 2003 in the city of Kohtla-Järve. Following some very heavy rainfall over a short period of time, Kohtla-Järve's drainage system failed causing the city to flood.

GERMANY
Hamburg

1 Schieswig-Holstein
2 Mecklenburg-Vorpommern
3 Hamburg
4 Bremen
5 Niedersachsen
6 Sachsen-Anhalt
7 Berlin
8 Brandenburg
9 Sachsen
10 Thüringen
11 Hessen
12 Nordrhein-Westfaten
13 Rheinland-Pfalz
14 Saarland
15 Baden-Württemberg
16 Bayern

Figure 5

Map of Germany (including the Federal capital of Germany)

is divided into sixteen Bundesländer or Federal States that form the Federal Republic of Germany. The three northernmost Federal States of Germany are situated along the Baltic Sea coastal rim: Hamburg, Mecklenburg-Vorpommern and Schleswig-Holstein. The following sub-sections provide some descriptive details concerning each of these three German Federal States, their coastlines and experiences of coastal flooding as well as their river systems and experiences of river flooding. Finally this sub-section provides some general observations regarding experiences of pluvial flooding, flash flooding and urban flooding within northern Germany.

Summary description

officially known as the Free and Hanseatic City of Hamburg, is situated in northern Germany at the southern point of the Jutland peninsula, positioned next to the border between Germany and Denmark. Hamburg is located at an important crossroad between Continental Europe to the South, Scandinavia to the North, the North Sea to the West and the Baltic Sea to the East.

is the second largest city in Germany and home to approximately 1.8 million people living in an area of 755 km². The city has become an important financial, media and industrial centre and a major transport hub for northern Europe. The Port of Hamburg is the second largest in Europe.

It's climate is described as a temperate maritime climate which is influenced by its close proximity to the coast, although it is situated inland and has no coastline. The landscape of the city is marked by the separation of the city by the River Elbe and low-lying marsh areas and sandy uplands. Hamburg has more bridges within its city limits than any other city in the World and the waterways of the city (at a total length of 640 km) are crossed by no fewer than 2,300 bridges.

River systems and river flooding →

Hamburg is situated on the confluence of the River Elbe with the Alster and Bille Rivers. Whilst the natural topography of the city is predominantly flat with very gentle rolling hills, the construction of a substantial network of dykes along the River Elbe to provide protection from flooding (and, in particular, storm surges/tides) has ensured that human actions have substantially influenced the city's topography.

For information, Figure 6 presents a map of the areas of Hamburg that are considered to be at high risk of flooding. It is estimated that an area the size of 200 km² (26% of the total land area of the city) is currently at risk of flooding.

Coastline and coastal flooding →

Hamburg is situated 100km from the coast and does not have its own coastline, but the River Elbe is tidal dependent and is subject to storm tides/surges on a reasonably frequent basis. One devastating storm surge occurred in Hamburg during the night of the 16th and 17th February 1962. During this event, Hurricane Vincinette tore across northern Germany with gusts of more than 200 km per hour. This storm caused a storm surge in Hamburg of 5.70 metres above mean high water level. During the surge, the River Elbe burst its banks and defences in

Hamburg

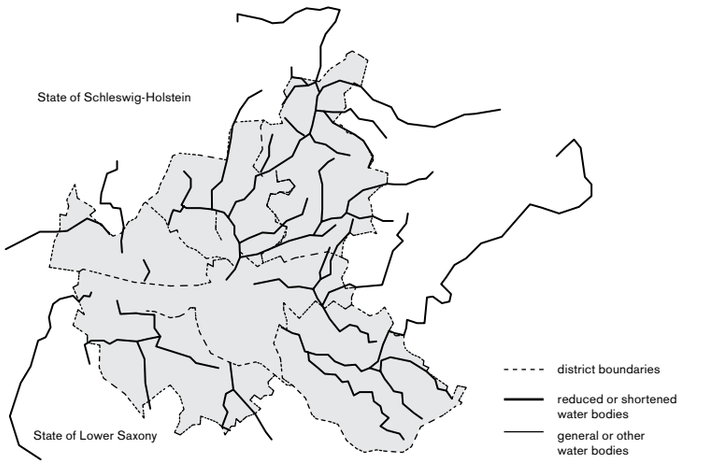


Figure 6 Hamburg's Inland Waterways

Coastline and coastal flooding →

more than 60 places, inundating low-lying residential districts and a total estimated area of 120 km². 330 people were killed by the floods and more than 60,000 people were made homeless. The disaster prompted a massive aid response with the rapid deployment of 8,000 German soldiers, 4,000 military personnel from NATO countries and numerous personnel from Hamburg's administration (mainly fire-fighters and dyke protection units) as well as civil aid organisations. The experiences of this tragic event have had a profound impact on the flood prevention and response measures implemented in Hamburg since February 1962.

Mecklenburg - Vorpommern

Figure 7

Map of Mecklenburg-Vorpommern (including the Federal State capital)

Summary description

is the sixth largest German state in terms of total land area, but it is also the least densely populated. The state borders the German states of Schleswig-Holstein (West), Lower Saxony (South West) and Brandenburg (South). Three of Germany's fourteen national parks and several hundred nature conservation areas are located in Mecklenburg-Vorpommern.

The State Capital and second largest city in the state is Schwerin with a population of approximately 95,000 people. The city is surrounded by a number of lakes, the largest of which is 60 km² and called the Schweriner See. An important landmark of the city is Schwerin Castle, which is located on an island in the Schweriner See. For centuries this castle was the residence of the Dukes of Mecklenburg and today it is now the seat of the Landtag (State Parliament).

Coastline and coastal flooding

The State of Mecklenburg-Vorpommern has a coastline of 1,945 km, 60% of which belongs to more than 50 islands and peninsulas found along the state's coast. The climate has few maritime influences from the west and is considered to be moderate continental.

In Mecklenburg-Vorpommern, 1,020km of coastline is actively protected against flooding, while a total of 461km is at risk of flooding. 377km of the coastline is adjacent to the open sea and 1,568km is adjacent to lagoons called "Boddens". A Bodden is a lagoon of water with a very high level of salinity which is separated from the open sea by spits of land. The Boddens were artificially created in the 19th Century to provide protection from coastal flooding and to this day they provide the Mecklenburg-Vorpommern coastline with protection against storm surges. The other key flood protection measures that have been implemented along the Mecklenburg-Vorpommern coastline include dykes (212 km) and dunes (105 km). The justification for the expansive flood protection measures along this Baltic Sea coastline is confirmed by the calculation that in the case of a 1 in 100 year event, a storm surge in the region could put 188,000 inhabitants at risk and could inundate 1,100 km² of land.

River systems and river flooding

The river basins of the Elbe, Oder, Schlei/Trave and Warnow/Peene have a strong influence on the geography of Mecklenburg-Vorpommern. In addition, Mecklenburg-Vorpommern contains 26,000 km of canals and rivers and 2,028 lakes that cover an area of 738 km². River flooding is relatively common within the rivers' floodplains, but it has been determined by some sources that there are no people at risk of flooding within these areas.

Schleswig-Holstein

Figure 8

Map of Schleswig-Holstein (including the Federal State capital)

Summary description

is situated at the base of the Jutland peninsula between the North Sea in the West and the Baltic Sea in the East and is the northernmost of the sixteen Federal States of Germany. The state borders Denmark in the North, the German Federal States of Lower Saxony and Hamburg in the South and Mecklenberg-Vorpommern in the East. The capital and largest city in Schleswig-Holstein is Kiel, with a population of approximately 242,000 people. Kiel is located on the Kiel Fjord (Kieler Förde) and has become a major transport hub. The Kiel Canal (Nord-Ostsee-Kanal) is an extremely important waterway for northern Germany, cutting through the centre of Schleswig-Holstein to connect the North Sea and the Baltic Sea.

The western part of Schleswig-Holstein borders the North Sea and is predominantly characterised as lowland with few hills. The North Frisian Islands and the majority of the Schleswig-Holstein's North Sea coastline are part of the Schleswig-Holstein Wadden Sea National Park (Nationalpark Schleswig-Holsteinisches Wattenmeer in German), which is the largest national park in Central Europe. The eastern part of the state borders the Baltic Sea and is marked by bays, fjords and cliffs. The eastern areas of Schleswig-Holstein are composed of rolling or undulating hills and a number of lakes. Fehmarn is the only island situated off the eastern coast of Schleswig-Holstein.

Coastline and coastal flooding

The approximate length of Schleswig-Holstein's coastline is 1,190 km. The coastal areas have a population density of between 96 and 210 inhabitants per square kilometre and it is estimated that approximately 300,000 inhabitants are at risk of coastal flooding. There is regular annual flooding of agricultural land and the North Sea Islets (Halligen). Although the protected homesteads of Warften in the North Sea are more protected than the other islets, flooding here affects 230 inhabitants and an area of 23.11 km².

River systems and river flooding

There are three main river basins[9] in Schleswig-Holstein, which include: the Elbe, the Eider and the Schlei/Trave. Some of the rivers flowing through the state are tide dependent: the North Sea tides affect the Elbe, while the Baltic Sea tides affect the Rivers Eider and Trave. Following the EU Directive 2007/60/EC, the Rivers Bille, Alster, Trave, Stör, Kruckau and Pinnau all have defined floodplains as well as inland dykes. Another important waterway within the state is the Kiel Canal which connects the North Sea and Baltic Sea. It has been calculated that towns and cities in Schleswig-Holstein with more than 50,000 inhabitants are not at risk from 1 in 100 year floods.

9 In German, "Flussgebietseinheiten" or FGE.

Schleswig-Holstein

General Observations Regarding Flooding in Northern Germany

Very moist low pressure systems and storm fronts that arrive into northern Germany from a westerly direction, particularly during the winter months and less frequently in the summer months, sometimes cause very heavy rainfall. During persistent conditions, limited local pluvial flooding may occur.

It is rare for heavy rainfall to have an impact on urban drains and rain retention basins in northern Germany. Flash flooding is also very rare. However, temporally and locally limited urban flooding does sometimes occur, as do flash floods, and these are usually the result of summer thunderstorms and associated heavy rainfall. Urban flooding is occasionally caused by exceptions to this general pattern, including:

- Flooding during heavy rainfall in the autumn months when drains and sewers sometimes become blocked with leaves and other debris.
- Flooding caused by sewers blocked by hailstorms.
- Flooding caused when sewers become frozen due to low temperatures.

LATVIA

Figure 9

Map of Latvia

Summary description

has a population of approximately 2.1 million people living on a land area of approximately 64,500 km^2. Latvia is situated on the eastern edge of the Baltic Sea region, sharing land borders with Belarus, Estonia, Lithuania and Russia. Latvia's coastline is relatively short compared to other countries in the region at 531 km.

is relatively flat and low-lying with undulating hills: 98% of the country is situated below 200m above sea level. The highest point in Latvia is at Gaizinkalns which is 312m above sea level. The lowest point in Latvia sits at 0m above sea level.

41% of the Latvian territory is covered in forest and timber and wood products are one of the country's major exports. Approximately 10% of the territory consists of peat bogs, swamps, and marshes, some of which are covered by stunted forest growth.

River systems and river flooding

Latvia has a very dense network of rivers (12,000 rivers in total), but most of these tend to be short in length: only 17 rivers are longer than 97 km. The major rivers in Latvia include the Daugava, Lielupe, Gauja and Venta[10]. Latvia also has over 3,000 small lakes, most of which are eutrophic. The Daugava River is the longest river in Latvia at 1,020km and originates in Russia before meandering through northern Belarus and Latvia where it flows into the Gulf of Riga. The Daugava River's total decent of 98 m as it flows through Latvia has made it attractive for generating hydroelectric power through 3 hydroelectric plants and dams. Although the courses of some of Latvia's rivers have been altered, most of Latvia's large and medium-sized rivers retain their natural course.

More than 60% of the annual water volume of Latvia's six largest rivers comes from neighbouring countries, primarily from Belarus and Lithuania. These complex geographies necessitate close cooperation concerning the river systems and catchment areas, especially in relation to pollution and flood control. The dangers of a lack of cooperation were exemplified in November 1990, when there was an accidental spillage of 128 tonnes of cyanide derivatives into the Daugava River in Belarus. No warning was issued and the problems were only identified downstream in Latvia when dead fish were spotted.

One cause of river flooding in Latvia is inadequate management of water causes which leads to accumulation of debris into dams and subsequent flooding. In September 2010, a large area of Riga was flooded (Arcadia Park and surrounding territories) due to a blockage of the small Marupite River. The melting of snow and ice in Spring and the associated rises in river levels is also a common and frequent cause of flooding in Latvia, particularly in rural areas. Spring high waters are particularly extreme when there has been late thawing and melting of the winter snow and ice which has been accelerated by rainfall. The annual Spring high waters begin mostly in March and reach their peak in April.

10 The Water Management Law established four Water Basin Districts in Latvia (the Daugava, Lielupe, Gauja and Venta).

LATVIA

River systems and river flooding

While the increases in water volume associated with the Spring melt can cause flooding, the associated ice jams can also cause severe flooding. Ice jams are typically caused by a two-stage process: for stage one, the warmer temperatures of the Spring months cause melting and break-up of the ice on the rivers; and, for stage two, this broken ice is then transported downstream until it makes contact with intact ice cover or another obstacle (such as a dam or bridge), causing a literal pile up of ice. The force of the ice can cause damage, but even more likely is that water from the flowing river will build up behind the ice jam and eventually flood the surrounding area. This process can also occur several times along a river, particularly if temperatures fluctuate to cause repeated cycles of melting and freezing.

There is a tendency for ice jams to occur in the narrow curves of some of the rivers, but it is difficult to predict where subsequent flooding will occur upstream of the ice jams. In recent years, the Daugava River between Daugavpils and Palvinas and the Lielupe River around Jelgava have been identified as areas that are particularly susceptible to flooding caused by ice jams. It is quite common in practice in Latvia for authorities to use a variety of different measures to remove ice jams (for example, through mechanical means, detonation of explosives and the spreading of peat).

Coastline and coastal flooding

While river flooding is a frequent problem in Latvia, a greater risk to the cities, towns and villages along the Baltic Sea coast actually comes from coastal flooding because the low-lying land is vulnerable to storm surges. The risk is increased because of the population density along the Latvian coast: more than 1 million people (a little less than half of the total population) live in a band the width of 5 – 10 km along the Baltic Sea and the Gulf of Riga coastlines. According to recent results of a hydrodynamic modelling exercise, the greatest flood threat to Riga, the capital city, is from storm surges. The storm surges that do cause flooding in Riga tend to follow a typical pattern, commencing with a strong westerly wind (of more than 20 metres per second) for 2 to 3 days. The wind will then change to a north-westerly direction pushing large volumes of water up the Daugava and Lielupe Rivers causing river levels to rise and breach their flood walls. Under these conditions, it is common for some of the very densely populated districts of Riga to be flooded.

Urban flooding, flash flooding and pluvial flooding

The other significant flooding threat to Riga and other urban areas comes from urban flooding, flash flooding and pluvial flooding (ponding), with sudden and continuous downpours having the potential to overwhelm urban drainage systems. The sewer and drainage system in Riga city is currently unable to cope with extreme conditions and is liable to failure and subsequent flooding. During the Winter/Spring season of 2011/2012, intense rainfall combined with very rapid snow melt and the slow removal of snow accumulations along pedestrian and smaller side streets led to critical increases in water entering the drainage system and urban flooding.

POLAND

Figure 10

Map of Poland

Summary description

has a population of approximately 38.5 million people living on a land area of approximately 312,000 km^2. Poland is a large country situated within central Europe and shares land borders with numerous countries, including: Belarus, Czech Republic, Germany, Lithuania, Slovak Republic, Russia (Kaliningrad) and Ukraine.

The majority of Poland constitutes an unbroken plain that stretches from the northern Baltic Sea coast to the Carpathian Mountains in the South. The average elevation of the land is 173 m above sea level. The highest natural point is Mount Rysy at 2,499 m (situated in the Tatra Range of the Carpathian Mountains) and the lowest is Raczki Elblaskie at 1.8 m below sea level. Poland has two natural harbours along its northern coast: Gdansk and Szczecin. Approximately 60 km^2 of land along the Gulf of Gdansk is situated below sea level. 47% of the total land area of Poland is classified as agricultural land (47%) and a further 29% is classified as forest.

River systems and river flooding

The two largest rivers in Poland are the Vistula and Odra, both of which flow from South to North into the Baltic Sea. The Vistula River originates in the Tatra Mountains in south-central Poland and is the longest river in Poland at 1047 km long. It is also the longest river with an estuary in the entire Baltic Sea region. The Vistula basin is approximately 169,000 km^2 and drains approximately half of the entire country. The Odra River is 742 km long and has a basin area of 106,000 km^2. Combined, the Vistula and Odra Rivers drain 88% of the entire country, although the drainage effect on a large part of the terrain is quite weak, especially in the central lake region. The predominance of swamps and quite flat terrain across much of Poland hinders large-scale movement of water. It has also caused the formation of numerous large lakes, 9,300 of which are larger than 10,000 m^2. The Vistula and Odra rivers have two high-water periods per year. The first is caused by melting snow and ice dams in the Spring which increases the volume of water flowing downstream. The second high-water period occurs in July following annual heavy rains.

Coastline and coastal flooding

For the relative size of the country, Poland has a short coastline at just 770 km. Nevertheless, as is the case for other countries studied in the Baltic Sea region, storm surges do cause coastal flooding, with an average of 5 incidents of coastal flooding reported each year.

Flash flooding

Flash flooding caused by rapid increases in the volumes of the rivers may also occur in Poland, although these incidents tend to be less frequent than typical river flooding. When flash flooding does occur it tends to be the result of very heavy rainfall in the southern mountainous areas which leads to rapid increases of water flow downstream.

POLAND

Pluvial and urban flooding

Incidents of pluvial flooding and urban flooding do occur in Poland, but at present existing statistics are not specific enough to estimate the frequency and impact of these two types of flooding. The State Fire Service (SFS) collects information about all incidents connected with rainfall (15,000 per year), but in many cases these are minor incidents which create no life threat and cause only small losses. The research for this study was completed using the data collecting system (called EWID) which is used across the whole of Poland (on all levels from district to state). The EWID is a common source of information for the SFS; however, the system does not enable in-depth analysis of these types of minor events because there is no requirement within Polish regulations. Completion of a search for such detailed data would require a researcher to access each specific report from these minor incidents to find a common picture for this kind of event. This work was, unfortunately, beyond the scope and capacity of the project.

SWEDEN

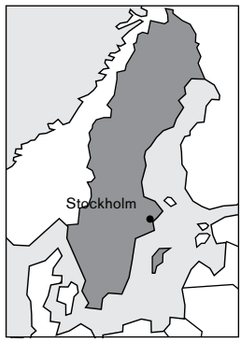


Figure 11

Map of Sweden

Summary description

is the largest country in northern Europe and the third largest in the EU, although it has a very low population density, particularly in the northern parts of the country. Sweden shares land borders with Norway and Finland and is connected to Denmark via the Öresund Bridge. The topography of Sweden mainly consists of gently rolling hills, but there are mountains in the west of the country along the border with Norway (the Skanderna Mountain Range). The highest point in Sweden is Kebnekaise at 2,104 m above sea level and the lowest point is the reclaimed bay of Lake Hammarsjön, near Kristianstad, at 2.41m below sea level. 78% of the country is covered in forest, while just 8% of the land area is classified as being used for agriculture.

it's climate varies considerably across the country, but is mainly temperate in the South and subarctic in the North. Approximately 15% of Sweden is located north of the Arctic Circle where the winters are long and very cold and the summers, although predominantly cool and short in duration, consist of very long hours of daylight per day.

River systems and river flooding

There are 119 rivers in Sweden with a catchment area of more than 200 km^2. The largest catchment area in Sweden is Göta Älv with an area of 50,000 km^2 (15% of the catchment area is actually located in Norway). Göta Älv is 731 km long, which makes it the longest river in Sweden. The second largest catchment area is the River Torne (Torne Älv) at 40,000 km2 (36% of the catchment area is actually in Finland). The total number of catchment areas in Sweden is approximately 37,000 (Source: www.smhi.se). Sweden is known as a lakeland country because of its 95,700 lakes. Lake Vänern is the largest lake in Sweden (5,648 km^2) and is the third largest lake in Europe.

The melting of snow and ice in the Spring and the associated rises in river levels is also a common and frequent cause of flooding in Sweden. While the increases in water volume associated with the Spring melt can cause flooding, ice jams can also cause severe flooding. As has been described earlier in this report, ice jams are typically caused by a two-stage process: for stage one, the warmer temperatures of the Spring months cause melting and break-up of the ice on the rivers; and, for stage two, this broken ice is then transported downstream until it makes contact with intact ice cover or another obstacle (such as a dam or bridge), causing a literal pile up of ice. The force of the ice can cause damage, but even more likely is that water from the flowing river will build up behind the ice jam and eventually flood the surrounding area.

Due to the low population density in many areas of Sweden, river floods are common but only some of these floods will have severe consequences for the population (i.e. will cause flooding of buildings, infrastructure or agriculture).

SWEDEN

River systems and river flooding →

Recent examples of some of the river floods that have occurred in Sweden include:

Arvika Flood, 2000: During the Autumn of 2000 the basin of the *Byälven* river in western Värmland was hit by severe floods due to more than three times the normal level of precipitation for October and November. Further information about this event is presented in Blue Book Two.

Småland Flood, 2003: Heavy rainfall which caused flooding in Småland in Southern Sweden, 5th – 10th July 2003. During this flood, 50 homes were flooded, storm drains failed causing the basements of a number of additional homes to be flooded with water and sewage, and communications infrastructure were damaged.

West Sweden Flood, 2006: A wet autumn in 2006 was followed by heavy rainfall during the first half of December which caused several rivers and watercourses in Western Sweden to flood. The centre of Mölndal was flooded and services on the West Coast Railway line were suspended for several days. A number of properties were damaged by water and many roads were forced to close.

A more comprehensive report published in 2012 provides an overview of all of the the most severe floods that have occurred in Sweden between 1901 and 2010.[11]

Coastline and coastal flooding →

The coastline of Sweden is very long at 3,128km and borders the Gulf of Bothnia in the North East, the Baltic Sea in the South and East and the Danish Straits of Skagerrak and Kattegat in the West. The lengthy coastline is dotted with thousands of islands, a small number of which are inhabited. There are estimated to be more than 20,000 islands and islets in the capital city of Stockholm alone.

Rises in sea-level combined with the passage of storm weather systems pose a risk to coastal areas of Sweden. For example, when storms Gudrun (2005) and Per (2007) passed Sweden, extreme rises in sea level were registered on the Swedish coast. A specification of the damage caused by the high sea level alone are unfortunately not available, but it is predicted that some damage was caused and there is potential for damage to be caused during future storm events.

Another issue that has been observed on the northern Swedish coastline, and northern Scandinavia more broadly, is the lowering of sea levels as a result of a continual uplift of the land following the last Ice Age. This uplift of nearly 1 centimetre per year is one of the highest rates of uplift found in the World. It is estimated that the land has uplifted by 300 centimetres since the Stone Age and, as a result, a number of Stone Age, Viking and medieval sites that were originally on the coastline are now found inland. One of Sweden's major ports in the

11 Alfredsson, C. (ed.) (2012) Översvämningar i Sverige 1901-2010 (Karlstad: Myndigheten för samhällsskydd och beredskap (MSB)). A copy of the report can be downloaded from the following website: https://www.msb.se/RibData/Filer/pdf/26098.pdf

SWEDEN

North, Lulea, is currently at risk of becoming too shallow to accommodate ships and expensive measures are now being taken to deepen the port to allow it to continue to operate[12]. This lowering of the sea level may have further implications in the future with regards to coastal and river flooding.

Pluvial flooding →

Pluvial flooding as a result of heavy rainfall can occur in Sweden and can be a problem. There are two recent examples of pluvial flooding that had a significant impact:

Hagfors, 2004: Heavy rainfall combined with thunder storms on 4th – 5th August 2004 led to pluvial flooding that destroyed many roads. The destruction of some roads led to 170 people in three locations becoming isolated over 2.5 days.

Orust, 2002: Heavy rainfall combined with thunderstorms on 2nd – 3rd August 2002 caused flooding of a number of residential, municipal and industrial buildings and made a number of roads impassable. A number of communities were isolated by the destruction of the road network and disruptions were caused to the telephone network (20,000 people without telephone access) and the electricity supply (6,000 people without electricity).

Urban flooding →

Urban flooding does occur in Sweden and it is often associated with failures in drainage systems that are unable to cope with very heavy rainfall over a short period of time. These floods may occur relatively frequently within small drainage systems with few consequences, however, they can also happen on a larger scale and can cause significant damage and disruption. An example of a recent urban flood is from Skoghall in 2006. Heavy rainfall during the night of the 25th August 2006 led to a failure of the drainage system and the flooding of 80 basements. The total cost of this urban flood was estimated at 8.6 million SEK.

Flash flooding →

Flash flooding does occur in Sweden. The most recent event occurred on 30th -31st August 1997 at Mount Fulufjället in western Sweden. The flash flood followed the largest amount of rainfall ever recorded in 24 hours in Sweden (estimated at between 300 and 400mm over 24 hours).

12 Further information concerning lowering sea levels in Scandinavia can be found at the following website: http://www.independent.co.uk/environment/climate-change/sweden-the-land-of-the-rising-coastline-8373787.html

Identified Gaps and Future Priorities for Flood Prevention Practice in the Baltic Sea Region

All of the Baltic Sea region countries studied during the project 14.3 stated that a key flood prevention priority over the coming few years is the successful implementation of the three phases of the EU Floods Directive (2007/60/EC)[13]. While this Directive provides all partners with a common priority, representatives of each country included within this study have identified other gaps in flood prevention practice that should be addressed within their own countries. This chapter provides a summary overview of these identified gaps and future priorities, looking at each country briefly in turn.

13 The first phase of the Directive involved the completion of preliminary flood risk assessments by the end of 2011. For the second phase, EU Member States are required to create flood danger maps and flood risk maps by the end of 2013 for those areas where a real risk of flooding has been identified. The third and final phase is the preparation of Flood Risk Management Plans (FRMP), and the target deadline is the end of 2015. These FRMPs will focus on the tripartite issues of flood prevention, flood protection and flood preparedness. They will outline measures to prevent and reduce damage caused by flooding to human health, the environment, cultural heritage and economic activity.

DENMARK

Danish Meteorologists are predicting a greater frequency of very heavy rain storms in the future. If this is the case, sewage and drainage systems will need to be expanded to be able to deal with increased water volume. This fact is evidenced by the severe flooding in Copenhagen in 2011.

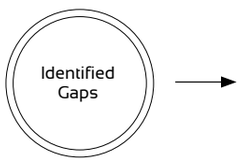
Within academic circles, the hottest trend for flood prevention studies is currently the development of strategies that involve directing the flow of water to areas that are considered suitable, typically with high drainage potential.

ESTONIA

In Estonia, three key gaps have been identified. The first is the need for more detailed understanding of flood risk to inform spatial planning. The second is a need for improvement of how the authorities inform the general public about dangers and how they communicate risk. The third and final gap is the lack of accurate data for flood risk assessment.

Besides the above mentioned EU Flood Directive, another key priority in Estonia is the development of new risk communication plans which will provide the general public with information about the threat of flooding and instructions on what to do during a flooding event.

GERMANY

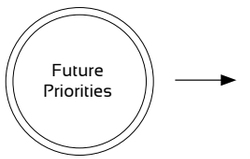


Within the three regions of Germany that this report focuses upon (Hamburg, Mecklenburg-Vorpommern, Schleswig-Holstein), four gaps in flood prevention practice have been identified.

The first gap is the need to fulfil the requirement outlined within the EU Flood Protection Directive (2007/60/EC) and the Water Framework Directive (2000/60/EC) for the preservation of coastal protection and flood defences. The second gap identified is the need for the implementation of the General Plan for Coastal Protection. The third gap is one that affects many countries and regions of the Baltic Sea and that is the need to avoid constructing and/or intensively cultivating natural flood plains. Both of these activities can significantly increase the likelihood and impact of flooding.

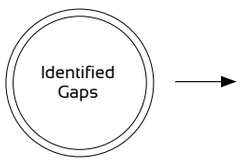
The fourth and final gap identified is relevant to all German Federal States. There is currently little cooperation and collaboration between the Federal States with regards to flood protection. This means that there is little acknowledgement of the potential consequences to neighbouring States of flood prevention measures that are implemented. Any flood prevention measure that is implemented, particularly hard engineering schemes, will alter the natural processes and balance of rivers and coastlines.

These alterations can, for example, cause water levels to rise or fall and/or increase or decrease erosion processes in other locations.



Hamburg, Mecklenburg-Vorpommern and Schleswig-Holstein have four future flood prevention priorities between them. In Schleswig-Holstein there are two current priorities and they are to meet the stipulations of the EU Water Framework Directive (2000/60/EC) and to implement a General Plan for Coastal Protection. Mecklenburg-Vorpommern also has a priority for implementing a General Plan for Coastal Protection, while Hamburg is aiming to meet the stipulations of the EU Water Framework Directive. Flooding experts in Germany also propose that more needs to be done by the Federal States to liaise, collaborate and cooperate with one another on flood prevention issues.

LATVIA



In order to address current gaps in flood prevention practice, Latvian experts have developed nine recommendations. The first recommendation is to amend some of the provisions of existing legislation. In particular, it has been recommended that the definition for a Protection Zone (Belt), as defined in the Protection Zone Law, should be extended.

The second recommendation concerns the methodology for the determination of Surface Water Body Protection Zones. It has been identified that recent advances in mathematics and observation techniques will enable the implementation of a more robust methodology for determining surface water bodies.

An important observation by experts in Latvia is that there are currently inconsistencies and ambiguities with regards to national and local governments' responsibilities for flood management, flood prevention and the provision of flood protection measures. Experts have therefore recommended that the politics of flood prevention and control need to be addressed to ensure there is adequate protection and that measures that are implemented are effective and cost efficient. In connection with this recommendation, it has also been recommended that special provision should be made in Latvia for the collection and analysis of statistical data relevant to land-use

planning and development in flood-prone areas by the national and local governments.

In recent years, urban areas in Latvia, like many across the Baltic Sea region, have experienced heavy rain storms and storm surges which have exceeded the capacities of the existing sewage and drainage systems. To prevent future floods in urban areas, it has been recommended that some sewage and drainage systems in Latvian towns and cities may need to be redesigned to improve their ability to manage higher water volumes. It is acknowledged that in some situations it may be necessary to create a system that enables authorities to divert high volumes of water to retention basins or other areas designated for flooding to prevent flooding in undesirable locations (residential areas, key transport routes and infrastructure etc.)

The sixth recommendation made by flood prevention experts in Latvia is that there is currently a lack of accurate data with regards to areas at high risk of flooding and the potential impacts of flooding in these high risk areas on people and property. This gap is, however, currently being addressed by a number of institutions in Latvia that are working together to comply with the stipulations of the EU Floods Directive.

LATVIA

Identified Gaps →

Flood prediction and modelling can be important tools for developing effective approaches to flood prevention. It has been suggested that the prediction and modelling capabilities of the national Environment, Geological and Meteorological Agency could be improved to enable a more timely prediction of forthcoming flooding events. In connection with this recommendation, it has also been suggested that planning documents within different economic sectors in Latvia currently include insufficient environmental information, such as environmental quality, flood risks, measures for prevention of industrial accident risks etc. The widespread integration of environmental data into spatial planning processes in Latvia is therefore another important gap to address.

The final recommendation from Latvian flood prevention experts concerns the current lack of insurance across the country against flooding and other natural disasters. Most common household insurances in Latvia do not currently insure policyholders against damage caused by natural disasters and there is a lack of awareness among the general public of this situation. It has been recommended that Latvian people and property could be better protected against the damage of floods if the State, local governments and insurance

LATVIA

Identified Gaps →

organisations do more to raise awareness of the different kinds of insurance products available (and the limitations of each product).

Future Priorities →

Three key future priorities for flood prevention practice in Latvia have been identified. These are:

1. To develop the National Programme for the Assessment and Management of Flood Risks 2008–2015 (approved by the Cabinet of Ministers) – the purpose of this programme is to develop a water protection system that will contribute to mitigate the effects of flooding, as well as to create a system for assessment and management of flood risks in order to reduce the adverse effects of floods within the community on human health, the environment, cultural heritage and economic activities. Appropriate financial recourses are allocated by the government and it is foreseen that additional funding (from EU Structural Funds) will be used for the implementation of these measures.

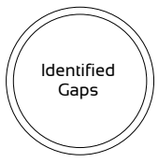
2. To integrate requirements of the EU Flood Directive into the River Basin Management Plans, to draft Flood Risk Maps and to carry out implementation measures for reducing flood risks.

LATVIA

Future Priorities →

3. During 2012, Riga City developed a Flood Risk Management Plan (FRMP) and Strategic Environment Impact Assessment (SEIA) for the City of Riga. These documents contain the results, measurements and conclusions of a substantial research project and comprise a detailed analysis of the current situation, future flood forecasts with various climate change scenarios and recommendations for specific measures to prevent and reduce flood risk in the future. The priority for the City of Riga will be the implementation of the FRMP over the coming years while the priority for other authorities in Latvia will be to use the work from Riga as a reference point for developing their own FRMPs and SEIAs.

POLAND



Two gaps in current flood prevention practice have been identified in Poland. The first is the significant time taken to implement local plans to prepare floodplains. The second is the apparent need for more restrictions on land use and construction on flood plains. At present there are laws stating that new buildings cannot be built on flood plains; however, exceptions can be granted and this can lead to the building of structures in area vulnerable to flood risk.

Over the coming few years, there are three priority flood prevention projects which will be run in Poland. The first project is called *Comprehensive Flood Protection forŻuławy – 2030*, with a first phase of the project expected to be completed by 2015. The aims of this project are multiple and include:

- improving the recognition of flood risk and the possibility of preventing it;
- increasing awareness of local communities and representatives of the administrations and institutions;
- improving organizational structures and flood protection for flood risk management at regional and local levels;
- rebuilding, reconstructing and constructing technical flood control equipment.

POLAND

The second key project is the *Programme for the Odra river – 2006 (1999-2016)*.

Again, the aims of this project are multiple and they include:

- building a system of passive and active flood protection;
- environmental protection and water quality protection;
- removal of flood damage;
- proactive planning and restoration of ecosystems;
- increasing forest cover.

Future Priorities →

The third and final project is the *Flood Protection Programme in the Upper Vistula Basin*. The ultimate aim of the project is to achieve a successive improvement in flood safety in the upper basin of the Vistula. This aim will be achieved through the completion of three key objectives:

- development of effective planning and implementation of flood protection measures;
- the development of prevention actions based around planning principles to reduce flood risk;
- imposing limitations to floodplain land use.

SWEDEN

Identified Gaps →

Sweden has recently developed a national strategy for protecting vital societal functions against flooding. For the time being an action plan is under production which will support the implementation of the national strategy. Implementation of the Action Plan and National Strategy are an important priority across the country for 2013.

See the following website for further information: www.msb.se/malaren

Following the final report from the Swedish Committee on Climate and Vulnerability, the Swedish Government has identified areas at risk that require more thorough investigation and research. These investigations will be an important priority in Sweden during 2013[14].

Future Priorities →

In addition to the key gaps that have been identified and which will be addressed during 2013, Sweden is implementing the measures required under the EU Floods Directive. Within the Preliminary flood risk assessment, Sweden identified 18 population centres that have significant potential flood risk. Flood hazard maps and flood risk maps will be produced for these areas during 2013. Flood risk management plans will then also be produced.

14 http://www.swedgeo.se/templates/SGIStandardPage____1353.aspx?epslanguage=SV

The Future of Flood Prevention in the Baltic Sea Region

> “ I flew over the flooded area in a helicopter to gain a first-hand impression of the situation. Thousands had sought refuge on roofs and would have drowned or frozen to death if we had not acted immediately. About a fifth of the city was under water. We knew that nothing like this must ever happen again. And so Hamburg invested huge amounts in flood controls in the years and decades that followed. [15] ”
>
> Helmut Schmidt, former Federal Chancellor,
> referring to the 1962 Storm Surge in Hamburg

The City of Hamburg has had to learn from the catastrophic storm flooding and resultant damage and loss of life that occurred in 1962. The event prompted substantial long-term investments into developing flood prevention and control measures. This reaction is fairly typical around the Baltic Sea region, and indeed around the World.

A severe flooding event causes substantial damage and/or loss of life and then prompts a re-evaluation of existing flood prevention measures and the implementation of a new approach to flood prevention and/or an extension of existing prevention measures.

There is no doubt that flood prevention can be costly. Construction development and land use changes have significantly altered the natural balances that once existed of European rivers and coastlines. This has made flood prevention more imperative, costly and complicated. **While flood prevention can be costly, it can also be cost effective and in many circumstances it can be considerably more cost effective than taking no further action and simply responding to major flooding incidents if and when they occur**. The old adage that “prevention is better than cure“ stands true. It is certainly the experience of the Baltic Sea region countries studied within the project 14.3 Task D that flood prevention measures that have been designed to protect against future changes in water levels (coastal, river, groundwater etc.) caused by climate variations, climate change and the periodic passage of

15 Munich RE (2012) Press Release: 50th Anniversary of the North Sea Flood of Hamburg: Subsequent flood controls prevent billions in losses - available at: http://www.munichre.com/en/media_relations/press_releases/2012/2012_02_13_press_release.aspx

severe storm systems can be extremely cost effective. To provide a specific example, according to calculations by Munich RE, the four storm surges that occurred in Hamburg since the 1962 flood would have caused economic losses of approximately €17.5 billion if the flood prevention measures had been kept at the same level as those in place immediately before the 1962 storm surge. The total amount invested in flood prevention improvements since 1962 is estimated at €2.2 billion. Therefore, the net losses prevented in Hamburg equate to approximately €15.3 billion[16] .

A key observation of this study implemented is that flood prevention needs to be addressed proactively.

↓

It is evident from Blue Books One and Two that countries in the Baltic Sea region are already being proactive and they are looking ahead to what the future might bring, particularly in light of current predictions regarding climate change. Throughout the last few decades, every country in the Baltic Sea region has developed its own methods and capacities for coping with flooding risk. These actions are in part being driven by the EU Directives, in part by previous experiences of severe flooding, and in part by local experiences and political motivations.

This study highlights the value of developing and implementing holistic approaches to flooding and flood prevention.

↓

This study has revealed the importance of assessing the risk of flooding and developing combined integrated approaches for reducing the likelihood and potential impact of flooding events. In essence, this study highlights the value of developing and implementing a holistic approach to flooding and flood prevention, both nationally and macro-regionally. It was observed by the partners that there is sometimes a tendency for professionals working on different elements of flooding problems to work in isolation from those working on other connected and interrelated parts of the problem. However, the reality is that prevention, preparedness, response

16 It should be noted that these calculations include an annual appreciation of €100 million to bring the costs in line with current values.

and recovery are all key elements of one big picture regarding flooding. Work completed in each one of these fields should be intricately linked with each of the other fields to produce a coordinated, integrated and holistic approach. To achieve a more holistic approach within most of the Baltic Sea region countries, it would be necessary to link together multiple stakeholders currently working in isolation into a coordinated framework which leads and drives all stakeholders to pursue a coordinated and mutually supportive approach to all flooding issues.

The Task D partners discussed and agreed that a template for a successful holistic approach would incorporate, as a minimum, the key elements presented in Figure 12 illustrated below. Figure 12 has been designed to provide a very specific visualisation of the holistic model concept. None of the elements has been labelled with a number or letter so as to emphasise that no single element is more important than another. In essence the Venn diagram that has been developed presents the concept of synergy: that the sum of the parts in combination is greater than the sum of the individual

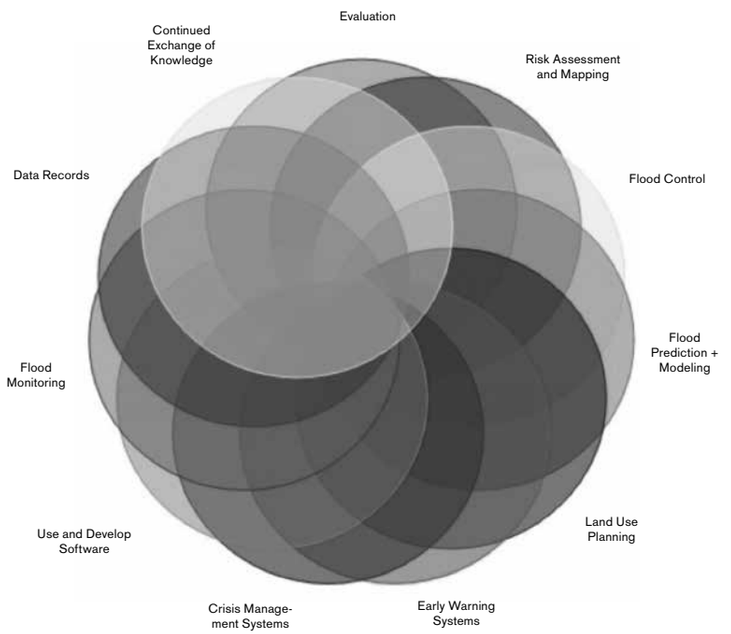
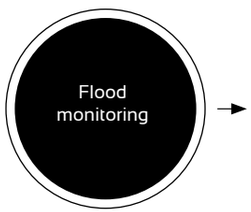


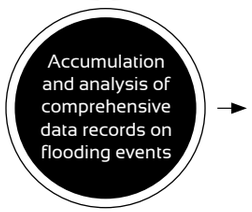
Figure 12 A proposal for a Holistic Approach to Flooding in the BSR

components in isolation. The overlapping circles present a complex myriad of shades that are layered together and, although around the edges you can depict the individual circles (elements), in the centre these circles merge into one combined shade. This mixing of the shades has been deliberately created to emphasise that all of the key elements should be closely interlinked and interrelated.

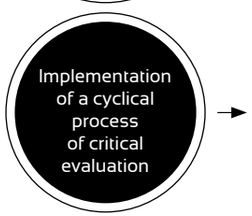
Each of the key elements presented in Figure 12 is now explained briefly below:



There is a need for the development and implementation of flood monitoring equipment, processes and procedures in order to measure and record water levels. This type of work has particularly important contributions to make towards building historical data sources and for risk assessment and evaluation.

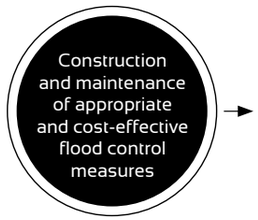


Data is of key importance for developing appropriate strategies for flood prevention, flood preparedness, flood response and flood recovery. The larger and more comprehensive the dataset, the more potential evidence that can be accumulated and interrogated. Without data there is no evidence on which to base decisions.

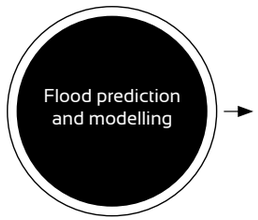


Including regular evaluations of the strategies and measures taken to prevent, prepare for, respond to and recover from floods.

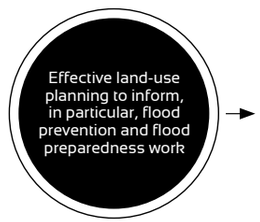
Mapping flood risk is of particular importance for preventative work such as identifying suitable locations for flood control measures and for developing appropriate land use policies and strategies. However, flood risk mapping can and should be used to make some important contributions to flood response and flood recovery plans. These latter contributions are perhaps less well evidenced within the Baltic Sea region countries studied and included within the scope of this report.



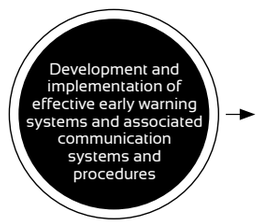
This means identifying specific locations - through analysis of historical data, risk assessment and flood mapping - where flood control measures may be effective at preventing and/or limiting damage caused by flooding, perhaps providing protection to vital infrastructure. It is also important that all flood control measures are regularly and sufficiently maintained in order to provide optimum protection and performance.



The ability to predict and model flooding is extremely important for developing effective plans across all key fields related to flooding. Prediction and modelling techniques for rivers and coastlines are continually advancing and provide practitioners with important tools that can and should be used to inform flood prevention, flood preparedness, flood response and flood recovery plans. These tools provide practitioners with a good indication of what might happen, or when it might happen and this can then be used to determine what responses and counter actions can be taken, and the potential implications of such actions.



In particular, innovative approaches at designing flood-proofed cities could and should become more commonplace around the Baltic Sea region. The design and construction of a flood-proofed city is based upon the central premise that flooding is inevitable in cities built in certain locations and that the city can and should be specifically designed so that it can cope better when flooding occurs.



Appropriate and effective systems must be developed to prepare stakeholder authorities and the general public for flooding events in higher risk areas. Early warning systems are of vital importance for helping both key groups to be prepared for the onset of flooding. In the most extreme cases, early warning systems can help predict severe flooding and enable stakeholders to implement evacuation plans and/or other mitigation strategies in advance of the arrival of the flood.

It has been shown that clearly defined and comprehensive crisis management systems are of vital importance for ensuring an effective response to flooding when it occurs. These systems and procedures should be a key part of stakeholders' preparedness for flooding and should be tried and tested prior to the occurrence of a flooding event.

The use and development of innovative multimedia software tools to support work in flood prevention, flood preparedness, flood response and flood recovery.

There needs to be systems in place to enable the continued exchange of knowledge, experience and good practice both within the Baltic Sea region and between this region and other regions of the World.

Many of the Baltic Sea region countries included within the scope of Task D work are already developing and implementing innovative and holistic approaches to flood prevention. Through Task D, knowledge and experience of developing and implementing these approaches has been exchanged and awareness of what is being developed within individual countries has now been raised. Baltic Sea region countries are also now more aware of some of the different stakeholders, which will help aid future cross-border communication.

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Key Stakeholders in Flood Prevention in the Baltic Sea Region

As part of the process of collecting data to inform the content of this report, partners working on Task D compiled a list of key stakeholders in flooding and flood prevention within their countries. For general information, the names and website addresses of these stakeholders are listed below.

Denmark	Danish Coastal Authority	www.kyst.dk
	Danish Meteorological Institute	www.dmi.dk
	Danish Ministry of the Environment	www.mim.dk/eng
	Danish Ministry of Transport	www.transportministeriet.dk/en
Estonia	Estonian Ministry of the Environment	www.envir.ee
	Estonian Meteorological and Hydrological institute	www.emhi.ee
	Estonian Ministry of the Interior	www.siseministeerium.ee
	Estonian Rescue Board	www.rescue.ee
	County and Local Governments in Estonia	Various website addresses
Germany (Schleswig-Holstein)	Ministerium für Energiewende, Landwirtschaft, Umwelt und ländliche Räume (MELUR)	www.schleswig-holstein.de/UmweltLandwirtschaft /DE/WasserMeer/ein_node.html
	Landesbetrieb für Küstenschutz, Nationalpark und Meeresschutz	www.schleswig-holstein.de/LKN/DE/Behoerde/behoerde_node.html
	Innenministerium Schleswig-Holstein, Referat Feuerwehrwesen, Katastrophen- und Zivilschutz	www.schleswig-holstein.de/IM/DE/Innere Sicherheit/ Katastrophenschutz/Katastrophenschutz_node.html
	Untere Katastrophenschutzbehör- den der Kreise / kreisfreien Städte	
Germany (Mecklenburg-Vorpommern)	Ministerium für Landwirtschaft, Umwelt und Verbraucherschutz Mecklenburg-Vorpommern	www.regierung-mv.de/cms2/Regierungsportal_ prod/Regierungsportal/de/lm/Themen/Wasser/ Hochwasserschutz/index.jsp
	Ministerium für Inneres und Sport Mecklenburg-Vorpommern	www.regierung-mv.de/cms2/Regierungsportal_prod/Regierungsportal/de/im/index.jsp
	Untere Katastrophenschutzbehörden der Landkreise in Mecklenburg-Vorpommern	

Germany (Hamburg)	Behörde für Stadtentwicklung und Umwelt (BSU)	www.hamburg.de/bsu
	Landesbetrieb Strasssen Brücken Gewässer (LSBG)	http://lsbg.hamburg.de
	Behörde für Inneres und Sport (BIS)	www.hamburg.de/katastrophen-schutz
	Die Bezirksämter Hamburgs	www.hamburg.de
Latvia	Local Municipalities	www.latvija.lv/LV/WebLinks/Justice/pasvaldibas
	The Latvian Ministry of Environmental Protection and Regional Development	www.varam.gov.lv/eng
	The State Fire and Rescue Service of Latvia	www.vugd.gov.lv/eng
	Latvian Environment, Geology and Meteorology Centre	www.meteo.lv/en
Poland	National Water Management Authority	www.kzgw.gov.pl
	Institute of Meteorology and Water Management - National Research Institute	www.imgw.pl
	Wojewódzkie Zarządy Melioracji i Urządzeń Wodnych (Voivodship Administration of Melioration and Water Installation)	
	Urzędy Wojewódzkie (Provinces Offices)	Various website addresses
	Urzędy Marszałkowskie (The Offices of the Marshals of Voivodeships)	Various website addresses
	Zarządy Melioracji i Urządzeń Wodnych (Administration of Melioration and Water Installation)	
	State Fire Service	www.kgpsp.gov.pl
Sweden	290 Municipalities (Local Level)	List of all municipalities and websites are found at: http://www.skl.se/kommuner_och_landsting/om_kommuner/kommuner
	County Administrative Boards (Regional Level)	www.lansstyrelse.se
	Swedish Civil Contingencies Agency (MSB) (National Level)	www.msb.se

Useful Websites for Flooding and Flood Prevention

Workshop 1 – Land Use Planning and Flood Prevention 21 November 2012, Riga

General information resources:

The EU Floods Directive 2007/60/EC http://ec.europa.eu/environment/water/flood_risk/

The EU Water Framework Directive 2000/60/EC: integrated river basin management for Europe http://ec.europa.eu/environment/water/water-framework/

COMMIN project - comparison of spatial development and planning information around the Baltic Sea Region (2007) http://commin.org/en/planning-systems/national-planning-systems/

Handbook on Good Practices on Flood Mapping (including examples from 19 European countries, USA and Japan) http://ec.europa.eu/environment/water/flood_risk/flood_atlas/index.htm

Land use planning and flood prevention in Germany:

Hamburg Ministry of the Interior and Sports, State Department of Disaster Response Management and Civil Protection http://www.hamburg.de/katastrophenschutz/

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www.hamburg-port-authority.de

Landesbetrieb Straßen, Brücken und Gewässer Hamburg
http://lsbg.hamburg.de/

Inland Flooding
http://wabiha.de/wabiha/startseite

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http://www.schleswig-holstein.de/Portal/DE/PolizeiKatastrophenschutz/Katastrophenschutz/Katastrophenschutz_node.html

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http://www.katastrophenschutz-mv.de

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www.thw.de

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www.feuerwehrakademie.eu
Hamburg Fire and Rescue Service
www.hamburg.de/feuerwehr

Land use planning and flood prevention in Denmark:

Danish Emergency Management Agency (DEMA) - http://brs.dk/eng/Pages/dema.aspx

Land use planning and flood prevention in Latvia: Riga City Project
http://www.rigapretpludiem.lv/eng/

European Centre for Climate Adaptation
http://www.climateadaptation.eu/latvia/en/

Land use planning and flood prevention in Poland: The Informatics System for National Protection against extraordinary natural hazards (ISOK) Project http://www.isok.imgw.pl

Workshop 2 – Ice-jamming and Flood Prevention 22 November 2012, Riga

Information regarding ice formation:

River and lake ice formation www.unep.org/geo/geo_ice/PDF/GEO_C8_LowRes.pdf

River ice formation http://nhlakes.mylaketown.com/uploads/tinymce/nhlakes/News%20Articles/Lake%20Ecology/2-6%20How%20Rivers%20Freeze.pdf

River ice modelling in a regulated, shallow and steep Norwegian river www.forskningsradet.no/servlet/Satellite?blobcol=urldata&blobheader=application%2Fpdf&blobheadername1=Content-Disposition%3A&blobheadervalue1=+attachment%3B+filename%3D%22Netrat.pdf%22&blobkey=id&blobtable=MungoBlobs&blobwhere=1274500073401&ssbinary=true

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Classification of Floods www.eolss.net/Sample-Chapters/C01/E4-06-02-05.pdf

Glossary of Ice Terms www.nrlmry.navy.mil/forecaster_handbooks/Arctic/Forecasters%20Handbook%20for%20the%20Arctic%20Appendix%20A.pdf

Ice Handbook for Engineers http://lakeice.squarespace.com/storage/ice_handbook_2009-1.pdf

Frazil- and anchor ice on Latvian rivers http://iahs.info/redbooks/a023/023031.pdf

CRREL Ice Jam Database www.crrel.usace.army.mil/library/crrelreports/CR99_02.pdf

Influence of an ice regime http://www.riverice.ualberta.ca/IAHR%20Proc/20th%20Ice%20Symp%20Lahti%202010/Papers/041_Agafonova.pdf

Prevention and Mitigation of Ice-Jams: New Brunswick River Ice Manual www2.gnb.ca/content/dam/gnb/Departments/env/pdf/Publications/RiverIceManual.pdf

A Pilots' Guide to River Ice www.crh.noaa.gov/Image/abr/riverwatch/RiverWatch_pilots%20handbook.pdf

Videos and photographs related to ice-jams:

Canadian approach to ice-jamming (Rideau river, Ottawa)

Ice cleaning www.youtube.com/watch?v=2BynH0Bdj_w

Ice cutting www.youtube.com/watch?v=QWeXW_koCY4

Ice blasting (Ottawa ice dam busters, shown on BBC One)
www.youtube.com/watch?v=uvfWiKFTces
www.youtube.com/watch?v=DxufH45xuwE
www.youtube.com/watch?v=_8U62TyIIZc

Post-blast work www.youtube.com/watch?v=9MV8xWu9Zfk

Information about flood control measures http://ottawa.ca/en/residents/water-and-environment/air-land-and-water/rideau-river-flood-control

Press releases and photographs www.ottawasun.com/2013/03/02/city-crews-blow-up-icy-rideau-river-to-fight-flooding

Photographs and videos www.ottawacitizen.com/news/Photos+Video+Rideau+River+cutting+begins/7961189/story.html

Canadian approach to ice-jamming (Winnipeg):

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Russian approach to ice-jamming:
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Russian Air Force bombing ice on a river http://articles.latimes.com/2001/may/18/news/mn-65062

Latvian approach to ice-jamming:

Latest photographs and video of ice blasting www.delfi.lv/news/national/politics/fotoreportaza-ogres-upe-spridzina-ledu-nbs-komandieris-pateicigs-video.d?id=43226894

Ice blasting in Latvia in 2010 www.youtube.com/watch?v=ILR6-13LjOU

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Workshop 3 – Software in Flood Prevention
9-10 April 2013, Warsaw

Decision Support Systems and Flood Modelling www.unesco-ihe.org/Flood-Management-Education-Platform/Flood-Modelling-for-Management2/4.2-Decision-Support-Systems-for-Flood-Management

Early flood warning system for the Baltic Sea http://demo.regio.ee/iap/web/app_dev.php/ Riga City Project - http://www.rigapretpludiem.lv/eng

Sea Wave Model (forecast) www.meteo.pl/index_en.php

High Resolution Operational Model for the Baltic (HIROMB) www.emhi.ee/index.php?ide=14,194,195

METOC portal http://on-line.msi.ttu.ee/metoc/ Sea Level Information System - http://on-line.msi.ttu.ee/kaart.php?en

Baltic Operational Oceanographic System (BOOS) www.boos.org

DMI ocean forecast portal http://ocean.dmi.dk/anim/index.uk.php

Geoinvent Zapora Modelling Software http://www.geoinvent.com.pl/zarzadzanie_kryzysowe.html?file=tl_files/ulotki/Ulotka_zapora.pdf
OceanWeb - http://www.smhi.se/hfa_coord/BOOS/Oceanweb.html

My Ocean, Ocean Forecasting and Monitoring www.myocean.eu

Climate Change Information
European Centre for Climate Adaptation
www.climateadaptation.eu/latvia/en/

Impacts of Europe's changing climate — 2008 indicator-based assessment www.eea.europa.eu/publications/eea_report_2008_4

Climate Change Adaptation in Denmark
www.klimatilpasning.dk/ (Danish) and http://en.klimatilpasning.dk/ (English)

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Notes

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