THESEUS: Innovative technologies for safer European coasts in a changing climate

SCIENCE POLICY BRIEF 2

EC Flood Directive 2007/60/EC
Flood hazard maps and flood risk maps (Article 6; Article 14)

Project THESEUS

Promotion of “healthy” coasts for both development and the natural environment taking into consideration governance structures, natural responses to coastal processes and perceptions of flood risk. Development of an integrated methodology for risk assessment of coastal flooding and erosion taking into account the changing climate and integrating the best technical and adaptive capacity in coastal management in a strategic framework; including response strategies and application.

Policy focus

Contribution to consolidated methodologies for risk assessment with analysis of drivers and impacts of changing flood risk and uncertainties in coastal processes.

Purpose of this policy brief

Floods should be mapped in terms of extent, depth/level and if relevant velocity, and indicate adverse consequences such as population, economic activity, release of pollutants, and other relevant factors.
The maps should consider different scenarios characterised by:

1. Low probability, i.e. extreme event scenarios;
2. Medium probability (likely return period ≥100 years);
3. High probability, where appropriate.

THESEUS project contributes to advance the methodology –at European scale- for coastal flood mapping by means of:

- Development and harmonisation of probabilistic tools for estimating hazard scenarios related to climate variability and change;
- Improvement of the knowledge of vulnerability and resilience;
- Improved assessment of the damages to infrastructure, environment and human activities; impacts on society, including change of social cohesion, livelihoods, and opportunities.

Key policy milestones requiring technical / scientific support:

Flood hazard and risk maps are due by 22 December 2013 (FD Article 6.8), updated by 22 December 2019 and every 6 years after (FD Article 14.2).

Relevant THESEUS outputs and key findings

THESEUS key findings are based on the activities carried out in 8 representative case study sites around Europe: Varna spit (Bulgaria), Vistula delta plain (Poland), Elbe estuary (Germany), Scheldt estuary (Belgium/Netherlands), South Devon (UK), Gironde estuary (France), Santander spit (Spain) and Po Delta coastal plain (Italy).

- Flood hazard and risk maps provide essential information for the planning and preparation of response to the occurrence of extreme sea levels. They are also an important part of communicating the potential the effects of climate change and the uncertainties associated with these estimations.
  - Extreme sea levels causing flooding usually correspond to a joint event of storm surge and a high astronomical tide. These events also allow large waves to propagate onshore. Rising sea levels will raise these extreme water levels and often increase extreme near-shore wave heights.
  - Land subsidence can be an important contributor to relative sea-level rise. This is generally a slow but certain process. In areas with (deep) groundwater and/or methane abstraction and/or extensive land drainage it warrants detailed attention. Next to the consequences for flood vulnerability, problems with salt (ground)water intrusion may increase in the coastal areas.
  - The size of the area vulnerable to flooding for a given event can be estimated by a variety of methods, ranging from bath-tub analyses which just consider contours, to a range of hydrodynamic models that consider the defence failure and water flow. Hydrodynamic models are more computational expensive but the results are more realistic. The bath-tub models are simple, but overestimate the areas that are potentially flooded today, and will underestimate the growing problems due to sea-level rise and climate change around Europe's coasts.
- Linking flood area to consequences in terms of population, economic activity, etc. is greatly facilitated by modern spatial analysis tools and the often used chain 'map of flooded area – map of flooded people/habitats/facilities, etc. – estimate of consequences' appears straightforward. However, this may lead to inconsistent results, especially when dealing with highly dynamic and long-term conditions, and may also not capture the more intangible social and environmental consequences of flooding.
- Mapping social, economic, environmental vulnerability and resilience requires the identification of a set of indicators which fully represent the physical flood system and important consequences.
- Habitat mapping should always be included in flood risk assessments. Determining existing species, abundance, communities and botanical associations provides a baseline to establish habitat extents and conservation status. These parameters can then be used to identify habitat resilience, especially in relation to flood duration, and therefore their potential role in flood risk management.
- How to calculate the habitat value is actually a conditional concept, especially when discussing rare or threatened species. In certain cases, for example industrial species, this value may be easily calculated using the species market prices. For non-commercial species it can be formed on the basis of the regulations embedded in the existing environmental legislation. For example failure to achieve the requirements of Articles 13 and 14 of COUNCIL DIRECTIVE 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora is the imposition of a fine which can be used as a proxy for value. National legislation for Member States define

scales of fines related to killing/destruction of these species in the wild; deterioration of breeding sites or resting places; cutting, uprooting or destruction of plants per specimen

Limitations

- Determination of parameters which are relevant for social and economic consequences in flood risk assessment is problematic. These are often inter-dependent or may not be able to capture universal impacts due to a variety of reasons
- Analyses of present and future climate conditions for specific sites are best achieved by a set of common (Europe-wide) analysis complemented by site specific analyses accounting for the specific conditions and needs at the various study site.
- In the short term (2020s and2050s), mean sea levels to be used at local (i.e. high resolution spatial scale) can be extrapolated from historical data. Over longer time periods (2080s and longer) use of the IPCC scenarios is more applicable.
- Hydrodynamic models can be applied at local scale, providing detailed and accurate information about flooding depth and velocities; at regional/national scale, simplified models are needed. These, to date, generally map floods based on storm surge level only, without considering finite overtopping volumes, run-up and beach reshaping during storms.

Experiences gained/ Recommendations to policy makers – Next steps

The results from this project indicate that the following steps should be followed in order to flood hazard and risk maps:

1. The inclusion of social and ecological aspects into flood mapping and the determination of consequences is essential in the understanding of flood risk including the options for mitigation. It is particularly relevant where development activities are proposed in flood prone areas where laws, spatial plans and building regulations can all help reducing the impacts.
2. Addressing and explaining the uncertainties associated with flood mapping is important, particularly among those making, and those affected by, any decisions. This includes explaining the:
    a. probabilities of flood events: errors may occur e.g. through the extrapolation of short time series flood discharges;
    b. inundation area and depth: imprecision e.g. due to generalised digital terrain models or because of difficulties in estimating failure probabilities of flood defences;
    c. type and location of elements at risk: inaccuracies e.g. because of generalisations in spatial resolution and categorisation of land use data;
    d. value of elements at risk: values are often approximations or have to be disaggregated or have to cope with non-marketable elements such as valuable habitats or life;
    e. susceptibility of elements at risk: damage functions are often derived from poor empirical data.
3. Probabilistic approaches are a good method for presenting hazard/risk in an understandable way. Considering a full range of future scenarios also allows uncertainty in both the projection of climate conditions and modelling techniques to be addressed.

4. Flood risk strategies need to be developed over the long term to include factors such as climate change, especially sea-level rise and rising coastal development; financial and management commitment to selected strategies is required beyond typical decision timescales e.g. political.

Outlook - Accessibility of results

Project document repository: **www.theseusproject.eu**

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Further information on the THESEUS project

Starting/Ending date of project:
December 2009 – November 2013

Coordinator:
Dr Barbara Zanuttigh, University of Bologna

EC Contribution: 6’530’000 €

Type of R&D:
Large Collaborative Integrated Project

PROGRAMME: FP7 Environment (including Climate Change), ENV2009-1

Web-Link: www.theseusproject.eu

Additional technical / scientific information:

OD1.7: Report on consolidated methodologies for the assessment of coastal vulnerability and resilience to erosion and floods

OD1.10: Report on quantified scenarios analysis of drivers and impacts of changing flood risk

OD1.15: Integrated report on risk assessment in study sites: present and future scenarios; analysis of drivers and impacts of changing flood risk; uncertainties in coastal processes through monitoring systems; early warning tools

Related projects / activities:

- Programme PROVIA / Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (joint initiative of UNEP, WMO and UNESCO)
- CLIMSAVE, www.climsave.eu/
- PREPARED Enabling Change, www.prepared-fp7.eu
- CIRCE www.circeproject.eu
- MICORE (2011) www.micore.eu
- FLOODsite (2009) www.floodsite.net.
- RESPONSE (2009) www.coastalwight.gov.uk/response

Incorporating the correlation between upstream inland, downstream coastal and surface boundary conditions into climate scenarios for flood impact analysis along the river Scheldt Geophys. Res. Abstr. 13(6554), European Geosciences Union General Assembly 2011 Vienna, Austria

Zanuttigh, B.; Perini, L.; Mazzoli, P. (2011). Scenarios of combined river and sea water inundation along the Adriatic Coast. Geophys. Res. Abstr. 13(1694), European Geosciences Union General Assembly 2011 Vienna, Austria

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Participating countries/institutes:

IT	UniBo	Alma Mater Studiorum - Università di Bologna
ES	UC	Universidad de Cantabria
UK	UOP	University of Plymouth
DK	AAU	Aalborg Universitet
NL	INFRAM	INFRAM International BV
DE	GKSS	GKSS - Forschungszentrum Geesthacht GMBH
UK	SOTON	University of Southampton
FR	UVSQ	Université de Versailles St-Quentin-en-Yvelines
FR	CETMEF	Centre d'Etudes Techniques Maritimes Et Fluviale
UK	MU	Middlesex University Higher Education Corporation
PL	IMGW	Instytut Meteorologii I Gospodarki Wodnej
BG	IO-BAS	Institute of Oceanology - Bulgarian Academy Of Sciences
GR	AUEB-RC	Athens University of Economics and Business - Research Center
NL	KNAW	Koninklijke Nederlandse Akademie Van Wetenschappen
IT	CORILA	Consorzio per la gestione del centro di coordinamento delle attivita di ricerca inerenti il sistema lagunare di Venezia
PL	IBW PAN	Instytut Budownicta Wodnego Polskiej Akademii Nauk
UK	BANGOR	Bangor University
FR	BRGM	Bureau de Recherches Géologiques et Minières
DE	HPA	Hamburg Port Authority
FR	EID	EID- Mediterranée
LV	UL	Latvijas Universitate
IT	ISPRA	Istituto Superiore per la Ricerca e la Protezione Ambientale
BE	VLIZ	Vlaams Instituut Voor De Zee Vzw
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RU	IORAS	P.P. Shirshov Institute of Oceanology of Russian Academy of Sciences
USA	UD	University of Delaware
ME	UNAM	Universidad Nacional Autonoma De Mexico
CH	SKLEC	East China Normal University ECNU
TA	NCKU	National Cheng Kung University