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Partnership for Risk Reduction

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PARTNERSHIPS ARE AFFORDABLE & EQUITABLE POLICY INSTRUMENTS FOR DISASTER RISK REDUCTION

Risk management through multi-sector partnerships

The ENHANCE project has received funding under the Seventh Framework Programme of the European Union under grant agreement No 308438

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1. Introduction

The ENHANCE project aims at developing and analysing new ways to enhance society's resilience to catastrophic natural hazard impacts. It analyses and develops new multi-sector partnerships (MSPs) between public and private sectors, with emphasis on the financial sector. Key for achieving this goal is to analyse new multi-sector partnerships (MSPs) that aim at reducing or redistributing risk, and increase resilience. This document introduces a working definition of partnership, where MSPs are understood as (Manez et al, 2014):

"voluntary but enforceable commitments between partners from different sectors (public authorities, private services/enterprise and civil society), which can be temporary or long-lasting. They are founded on sharing the same goal in order to gain mutual benefit, reduce risk and increase resilience".

Ten participatory case studies on risk reduction, taking place at different geographical and spatial scales in Europe, are at the heart of the project. The case studies are related to heat waves, forest fires, floods, droughts, storm surges, and volcanic eruptions. Based on these case studies the project aims at developing and improving partnerships and risk information; it also suggests risk management measures and policy recommendations.

Risk has a different meaning to different people and the level of knowledge and access to information on risk differs in each country and region. In order to develop MSPs that can effectively reduce risk, the first step is to widen the risk information basis of stakeholders, through the development of risk assessment models, evaluation tools, a risk catalogue and toolbox, provision of an inventory of existing risk scenarios in Europe and an improved access to available risk related tools and information.

The development and improvement of MSPs often pertain to agreements between the private and public sectors. Analysing existing MSPs in the case studies, ENHANCE explores the roles of actors and stakeholders, and systematically examines their successes and failures in increasing resilience to natural hazards and disasters and their associated risks.

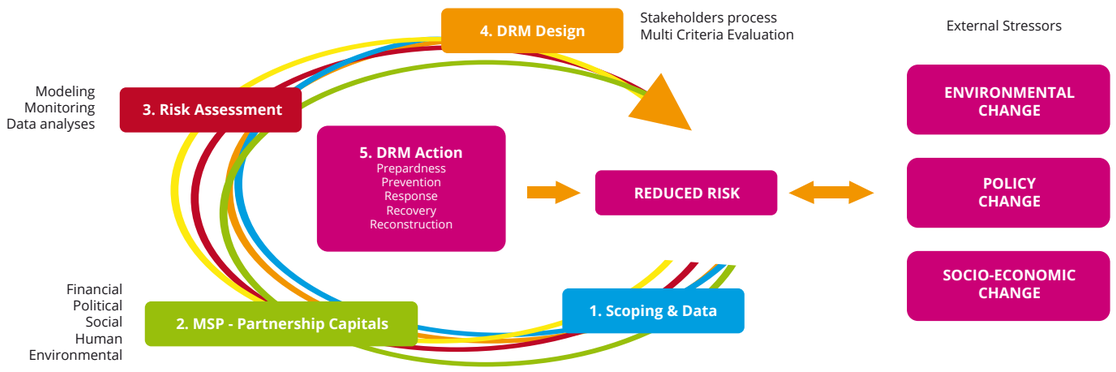
Accordingly, the project will describe indicators for successful and unsuccessful partnerships and recommendations will be provided as to how to improve cooperation to better manage risk.

ENHANCE further examines how MSPs can develop and implement measures to manage and reduce risk by **(1) disaster risk reduction (DRR)** and **(2) implementing economic instruments**.

- DRR Measures are analysed through an in depth analysis of existing DRR policies in Europe. Partners identify opportunities, barriers, normative gaps, and synergies between the existing regulatory and economic policy instruments for disaster risk reduction and develop recommendations for their successful implementation in MSPs.
- Economic instruments such as insurance, tax incentives or water pricing for enhancing resilience and managing risk, are analysed and criteria developed to assess them. ENHANCE contributes to the economic instruments debate related to risk management by providing a toolbox of economic instruments for assessing risk and increasing societal resilience.

ENHANCE FRAMEWORK

Multi Sectoral Partnerships (MSP) & Disaster Risk Management (DRM)



Finally, policy recommendations will be delivered to policy makers at the European Union, regional and national levels and will be used in the negotiations to design the Post 2015 Hyogo Framework for Action. ENHANCE is co-funded by the Seventh Framework programme of the European Union and brings together a representation of actors coming from academia and private sector as well as public authorities.

The ENHANCE project commenced in late 2012 and is expected to reach its final phase by the end of 2016.

This booklet provides the reader with a description of work performed by the ENHANCE project partners within its ten case studies. Each case study describes the situation connected to the risk of the given region/country and lists activities aimed to improve it. It highlights key figures and facts, and provides a full lists of stakeholders and partners working on the case studies. Overall, this booklet aims to underline the positive impact partnerships have on risk reduction and risk resilience.

**For more information about the ENHANCE project,
to access the project results and studies on cross-cutting topics:**

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2. Risk Information

Adequate risk information is needed to ensure risk partnerships can take robust decisions in disaster risk management. To date, most risk studies tend to focus on single hazard risks (e.g. wind storms, floods, or earthquakes). However, countries face emerging risks associated with extremely low-probability hazards, such as volcanic eruptions or major earthquakes, linked with new vulnerability patterns due to urban growth and society's interdependencies on technological systems (UNISDR, 2011), for example in the energy, telecommunications, finance and banking, and transport sectors. In order to contribute to better estimating hazard extremes, comprehensive assessments of uncertainty in risk assessments, as well as probabilistic risk assessments are needed. To progress beyond the current state of the art, ENHANCE provides a pan-European harmonised risk assessment scheme, focusing on extremes.

2.1 Existing Data

To take decisions and reduce risks, MSPs need different sets of risk scenarios to test their decisions. For example, historic and future climate information is available to show where weather extremes may affect people and economics assets (figure 1.).

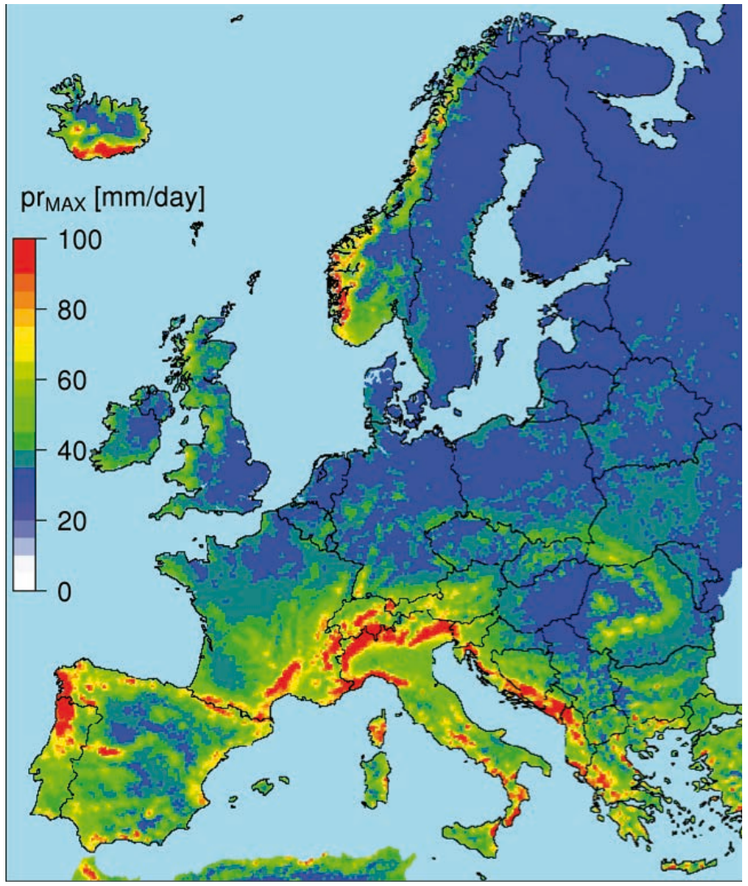

Figure 1. Annual maximum daily precipitation for period 1970 - 2005 derived from an ensemble of EURO-CORDEX regional climate simulations (Alfieri et al., 2015) [1].

[1] Alfieri, L., Burek, P., Feyen, L., and Forzieri, G.: Global warming increases the frequency of river floods in Europe, Hydrol. Earth Syst. Sci. Discuss., 12, 1119-1152, doi:10.5194/hessd-12-1119-2015, 2015.

For future projections of climate change, a large number of (regional-) climate simulations have been generated for Europe (e.g. within the EU funded projects: PRUDENCE and ENSEMBLES). It is currently standard practice not to rely on a single climate simulations, but rather to use an 'ensemble' of many possible climate simulations to account for uncertainty in climate projections. Figure 2 shows how heatwaves, coldwaves and hydrological droughts are projected to change in Europe during this century. The future probability of occurrence of a current (1981-2010) 100-year extreme event of these hazards was derived based on an ensemble of climate projections for the SRES A1B greenhouse gas emissions scenario (see Russo et al. (2014) [1] and Forzieri et al. (2014) [2] for further details)

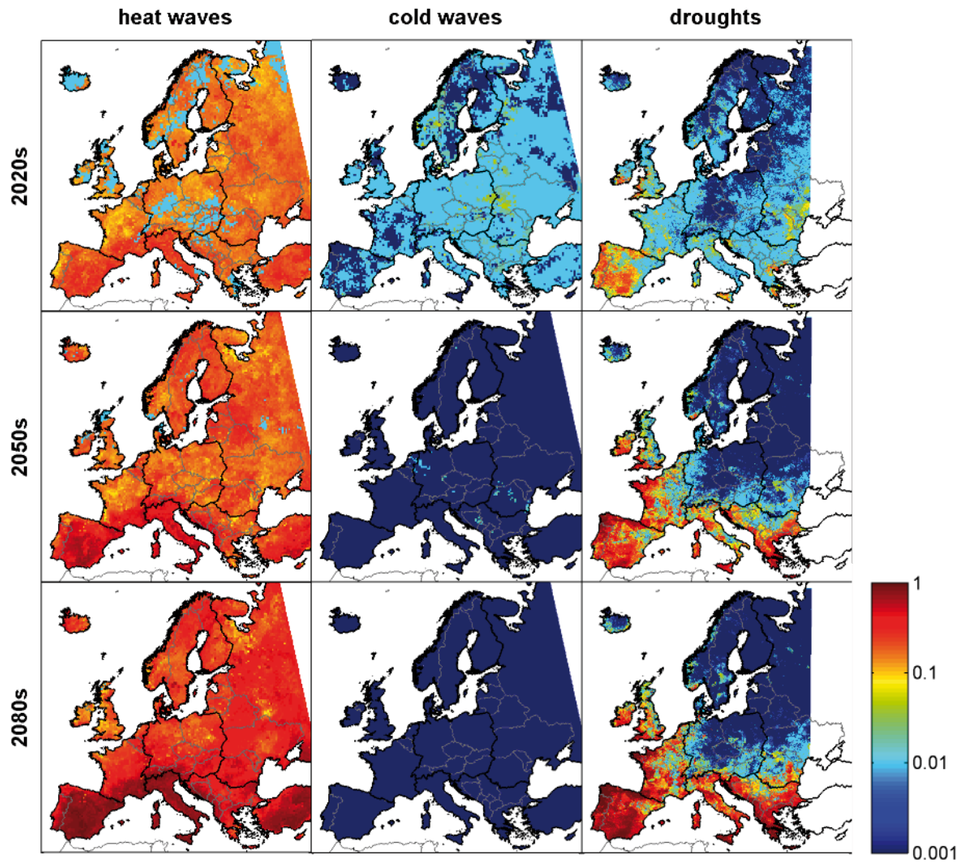

Figure 2. Probability of occurrence in future time windows of a current (1981-2010) 100-year (=0.01 probability of occurrence) climate extreme event. A decrease in probability (darker blue) indicates a reduction in hazard. A probability of occurrence equal to one means that a current 100-year event may occur every year in the future.

[1] Russo, S., A. Dosio, R. G. Graversen, J. Sillmann, H. Carrao, M. B. Dunbar, A. Singleton, P. Montagna, P. Barbola, and J. V. Vogt (2014), Magnitude of extreme heat waves in present climate and their projection in a warming world, J. Geophys. Res. Atmos., 119, 12,500–12, 512, doi:10.1002/2014JD022098.

[2] Forzieri, G., Feyen, L., Rojas, R., Flörke, M., Wimmer, F. and Bianchi, A. (2014). Ensemble projections of future streamflow droughts in Europe. Hydrology and Earth System Science, 18, 85–108.

2.2 Scenarios on hazard extremes

Given the advances until now, techniques to produce probabilistic risk estimates are either based on specific hazard event scenarios, or are up-scaled from lower to higher spatial levels by a summation of averages. However with the former, the whole possible range of hazard impacts is neglected while with the latter, the detailed probability distribution of losses is lost. In both cases risk management approaches for high layer risks (i.e. the fat tails or extremes) cannot be applied any longer. Yet, from a risk management perspective low probability events deserve special attention as they can cause extraordinary large losses eventually leading to failure of classic coping mechanisms (such as savings or taking loans) or risk spreading instruments (such as insurance).

One prime example are flood events as they are not regionally limited and have the potential to cause huge losses at once. In Europe, for example, the Odra flood in 1997 affected Czech Republic, Germany, Poland and Slovakia simultaneously and caused more than €5 billion total losses. The 2002 flood events were even more devastating, with around €14.4 billion of total losses in Austria, Czech Republic, Germany and Slovakia. The recent 2013 flood events affected 9 EU countries at once and caused €12 billion losses. These extreme events and corresponding losses caused huge stress on disaster financing mechanisms such as the European Solidarity Fund (EUSF). As these examples indicate, taking account of the interdependency of risks in case of extreme events is of importance in the managing of it. This necessity to incorporate interdependencies for the correct risk assessment led to a new approach on how to measure hazard extremes including its specific nature (ie. Increasing tail dependency). This was done via the use of copulas.

Copulas are useful for modelling dependencies between continuous random variables. Using a copula model allows to separate the selection of the marginal distributions (e.g. the risk in form of loss distributions) from the selection of the copula (e.g. the dependency between risks). In other words, while the marginal distributions contain the information of the separate risks, the copula contains the information about the structure of the dependency. Using flood as an example, the application of a copula approach makes it possible to estimate loss distributions between selected regions and countries, explicitly taking their dependency into account.

The ENHANCE work built and extended current discussions on this topic and suggested a new approach on how to obtain risk (or loss distributions) at larger scales for extreme event scenario. The main idea behind the approach is the estimation of the dependencies between regions which are dependent on the given magnitude of the event itself. For example, a small flood event in one region has less probability to happen in another neighboring region, while a large flood event in one region would have a higher probability that it will also happen in another region as well. Or in other words, small flood events are more likely to be geographically limited than large (high impact) flood events. Via the use of proxies for the interdependencies of such regions (or disasters), large and extreme event scenarios can be assessed and underestimation of losses avoided.

Large-scale risk analysis is a sophisticated procedure, which should incorporate the interdependencies between all considered regions and countries. Neglection of underlying interdependencies (i.e. approximation of the total risk curve via the convolution of regional risk curves) eventually leads to the underestimation of risk and to the potential failure of risk management strategies.

In order to answer the question about the hazard specific risk in multiple regions, it is necessary to estimate the probability loss distribution, that gives information on the probability of rare events (10-year event, 50-year event, 100-year event etc.) and the amount of loss in case of these events. In order to do this, one first of all must know the marginal loss distributions for each of the regions. Secondly, one needs to couple marginal losses in such a way that the large-scale probability distribution is estimated correctly and fits the multi-regional data on losses. For this, it is not enough to convolute marginal distributions, as this leads to the neglection of regional interdependencies, and it is necessary to find a non-linear dependency function (i.e. copula) that transforms the marginal probability distributions into a total probability distribution taking into account all interdependencies. Third, it is necessary to understand from the available data and geographical structure, which groups of regions can be considered as dependent, and which as independent and in which order these groups should be coupled. Therefore, different types of copulas (Gumbel, Frank and Clayton) and coupling techniques should be used for the best possible estimation of the disaster risk in multiple regions.

3. The heart of the ENHANCE project: 10 case studies

3.1 Air industry response to volcanic eruption

In the morning of April 15th 2010, thousands of air transport travellers around Europe were unpleasantly surprised; their flight could not take off. Airports shut down in several countries around Europe as the Eyjafjallajokull volcano in Iceland entered into eruption and emitted volcanic ash that spread across European airspace. Airspace was closed to commercial jet traffic; millions of passengers were affected over several days, causing worldwide distress and cost an estimated loss of US$ 5 billion.

Why is air traffic affected by volcanic eruption?

Volcanic ash is a major issue to aircraft. Emitted into the air, the ash can severely impact visibility for visual navigation (sandblast windscreens), damage the airplane jet engines (ash debris can melt due to the temperature of aircraft jet turbines) and potentially lead to engine failure.

With an ash plume at flight altitude spanning over Europe, many countries decided to close their airspace for safety reasons. Although politically sensitive, the downside effects of this decision led to a critical review of the EU regulation and procedure in order to improve risk management.

Beyond regulation, strengthening stakeholders cooperation

Since 2010, aircraft operators and policy-makers have reviewed the legislation and procedures, modifying the ash concentration levels and the no-flight zones (size, risk classification). ENHANCE seeks to further improve air traffic response to volcanic eruptions, by further reducing the impact of response decisions on passengers and the economy. ENHANCE aims at making the volcanic response partnerships resilient by:

- Identifying further possibilities for regulatory improvements and decision-making process;
- Refining stakeholders' cooperation and seeking improved ways of communication;
- Studying response plans for alternative modes of transport

ENHANCE partners offer information on how to reduce downsize effects of volcano eruptions to public authorities, what in turn would positively impact businesses and the life of millions of citizens in case of a future eruption with ash emissions.

" Eyjafjallajokull lead to the greatest disruption in air traffic since World War II "

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Case study - State of play

- The partnership conducted a first analysis of changes in procedures and regulations, models and inputs used in the decision process;
- Partners of the case study interviewed, amongst which representatives from the London Volcanic Ash Advisory Centre VAAC, airlines and air traffic control;
- It also develops potential risk scenarios.

In the coming months, case study partners:

- Intend to perform interviews with other representatives from the partnership;
- Organise a workshop to present and test scenarios to explore areas of improvement;
- Study response plan for alternative transport modes.

Facts and figures

- Volcanic ash presents a major issue to aircraft;
- After the Eyjafjallajokull volcano eruption, airspace was closed and air traffic and travellers were affected over several days;
- The Eyjafjallajokull volcano caused an estimated worldwide loss of US $ 5 billion.

Stakeholder involvement

- Icelandic Meteorological Office (IMO)
- London Volcanic Ash Advisory Centre (VAAC)
- Central Flow Management Unit of EUROCONTROL
- The European Commission's Directorate General for Mobility and Transport
- Representatives of airlines

3.2 Building railway transport resilience to Alpine hazards

The Austrian Alps host a beautiful landscape of mountains, valleys and rivers. Although being ideal for outdoor activities, it implies challenging engineering tasks for the construction and operation of the railway network. Over the years, given their central position in Europe, Alpine railways became key for freight transport and travellers with growing economic perspectives.

Yet, torrents, mudflow, rock fall, avalanches and floods lead to regular disruption of railway tracks, causing large economic damages and temporary closures of line sections as railway tracks and bridges can be washed away or can be severely damaged.

The Austrian Railway Infrastructure AG (ÖBB Infra), along with the civil and governmental partners are left with the difficult and costly mandate to assess risks, take preventive measures, and ensure the continuous operation of the network. Although done with dedication, the risk partnership suffers from mixed information exchange and cost-sharing divergence.

Improvement of structural and non-structural risk management

ENHANCE partners analyse and reinforce the existing partnership. It builds upon both structural (cost sharing) and non-structural measures (information exchange) to improve decision-making process with regard to Alpine hazards.

On one hand, given limited time and budget, effectiveness of preventive measures is necessary. ENHANCE provides improved knowledge for decision-making with a broader approach than the commonly applied cost-benefit analysis, by applying a multi-criteria analysis. On the other hand, partners deliver new insights on the current and future risks, as the hazard situation might change due to climate change.

As part of its commitments, ENHANCE brings in-depth study of the hazards through:

- A detailed risk assessment for floods and debris flows at various locations for railway tracks;
- A comparison of the frequency of critical events with the number of floods and debris flows;
- An analysis of how improved risk information will influence the cooperation between stakeholders and decisions to close tracks, or to implement risk reducing protection measures.

By analysing existing processes and combining them with new risk projections, ENHANCE provides a robust handgrip to secure current and future resilience in the Alpine railway lines whilst paying attention to costs shared by the different actors.

ENHANCE facilitates a stakeholder driven approach, where stakeholders in risk management together with research jointly seek improved multi-sector partnerships in a participatory way.

“Alpine railways are key for freight and travellers transport and subject to multi-hazard risks. In August 2005, floods blocked a section of an Alpine railway, it took €30 billion and 100 days to get it back in operation”.

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Partnership & Case study - State of play

- The Austrian Railway Infrastructure AG (ÖBB Infra) is the key player for all partnerships as the state of Austria is always financing projects for risk reduction. Nonetheless, the project found out that the Ministry of Transport is less involved in the mitigation of natural hazards when it comes to railways.
- The case study is currently developing a classification of possible damages to railway infrastructure and assesses the availability of railway lines in case of natural hazards.

Facts and figures

- A substantial share of the Alpine railway lines are exposed to a range of natural hazards such as torrents, mud flow, rock fall, avalanches and floods;
- Alpine railways are very important for European passengers and freight transport (central location in the EU);
- In 1995, a train on the Arlberg railway was hit by a mudslide, derailing the train and killing three passengers;
- The 2005 floodings caused a blockage of the Arlberg railway and it took €30 million and 100 days to get it back in operation.

Stakeholder involvement

- Austrian Railways – ÖBB Infrastruktur AG
- Austrian Service for Torrent and Avalanche Control
- Austrian Ministry for Agriculture, Forestry, Water and Environment
- Regional authorities

3.3. Climate variability and risk in the Po river basin

Amplified flood as a result of disrupted drainage infrastructure

In May 2012, Northern Italy experienced a devastating earthquake with the magnitude of 5.9 on the Richter scale in the downstream part of the Po River Basin District. The earthquake damaged critical components of the land drainage system and exacerbated flood risk over approximately 1000 km^2 of land.

The affected area holds several middle-sized urban centres (20-60 thousands residents), pieces of central infrastructure systems, and major industrial areas. The estimated potential losses over the entire quake-shattered area amount to €10 billion. The studied area is located in the low-altitude floodplains at the foot of the Tuscan-Emilian Apennines between the rivers Po, Secchia and Enzo. The impaired infrastructure, especially the ill-functioning water pumps that elevate and discharge the drained water into the Secchia river when the high water stages prevent outflow by gravitation, resulted in higher flood risk and hence potential economic damage.

Under these circumstances, the Land Reclamation and Irrigation Board (LRIB) Emilia Centrale has been temporarily unable to fully accomplish its statutory role. Together with the Po River Basin Authority (P-RBA) and the civil protection agencies of the affected regions (Lombardy and Emilia Romagna), a temporarily emergency plan has been devised which foresees controlled floods on low-value agricultural land that prevent large losses on high-value land uses, in particularly the urbanized areas on the border between Emilia Romagna and Lombardy.

A better understanding of risk in the area is critical for the partnership. ENHANCE assists this by improving hazard and risk assessment with research and in-depth analysis of the financial and economic instruments for equitable cost sharing arrangements. In addition, ENHANCE supports the partnership, initially conceived as a provisional arrangement, to become a constituent part of a medium- to long-term strategy of disaster risk reduction within the district.

Drought threat in the Po basin

The Po valley, a majority of which is comprised in the Po River Basin District (PRBD), is Italy’s largest contiguous agricultural land. The PRBD accounts for nearly 21% of the total agricultural area (TAA); 21.5% utilised agricultural area (UAA); almost entire national production of rice and about or more than a half of the national production of soft wheat, rye, maize, sorghum, and other cereals; and almost 30% of the agricultural value added. The basin is also one of the economic engines of the country.

Although the Po River Basin District is under normal conditions as one of the better water-endowed regions of Italy, the severe and persistent drought spells of 2003 and 2006-2007 proved Northern Italy's vulnerability to climate variability and change. During the 2003 drought, the Po River reached its absolute minimum water level ever with 270m³/s compared to an average of 1400m³/s.

The over allocation of water resources under the conditions of drought led to critical water shortages in agriculture, energy, and the public water supply.

Given the critical role of the region for Italian agriculture, industry and energy production, measures to prepare for future events had to be taken. The Drought Steering Committee (DSC), a forum of the river basin's major water users, was initiated in May 2003. Gathering private and public actors, the Committee is initiated early at the onset of a dry spell to regularly review the unfolding drought condition and deliberate potential actions to reduce the risk of water crisis and ensuing damage.

Improving the decision making process

The DSC makes important and wide-reaching decisions that were able to reduce the drought impact to some extent but are however economically sub-optimal.

The goal of the ENHANCE team's research consists of informing the DSC collaborative decision making about the economic efficiency of the adopted solutions to drought and demonstrating how **a more efficient allocation of water could be achieved by economic instruments** such as scarcity pricing, exchange of water entitlements and insurance.

"Although the Po River Basin District is believed to be exposed to relatively low seismic risk, the 2012 earthquake has demonstrated that low does not mean non-existent."

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Partnership - State of play

The ENHANCE partners have conducted analysis of how the earthquake amplified flood risk in the affected areas. It includes assessment of financial and economic costs caused by floods as well as assessment of avoided damage through controlled floods in low value land use areas.

The ENHANCE partners have estimated the impacts of climate variability and drought and change on agricultural production in the Po river basin district and estimated the willingness to pay for agricultural insurance.

Facts and figures

- In 2012 the Po River Basin District was hit by earthquakes with a magnitude of 5.9 (RS);
- The 2012 series of earthquakes damaged critical components of the land drainage system and exacerbated flood risk over ca. 1.000 km² of land;
- During the 2003 droughts the Po river reached its absolute minimum: 270 m³/s compared to an average of 1400 m³/s;
- The Po River Basin plays a critical role for Italian agriculture, industry and energy production.

Stakeholder involvement

- Regional Nature Protection Authorities in the administrative regions Emilia Romagna
- Land reclamation and irrigation board(s)
- Regional and provincial civil protection agencies

3.4 Drought management in the Jucar River Basin District

The Jucar River Basin District is one of the most vulnerable areas to drought in the western Mediterranean region. Hydrological droughts in this region are frequent. They can be very intense and long lasting (frequently for more than 3 years). Since the 1980s the Jucar River basin District suffered four severe periods of drought.

These extraordinary droughts set the urban water supply chain at risk and caused economic losses in agriculture and industry. Droughts also increased the risks to (nuclear) power plant cooling and acted as a trigger for desertification and forest fires. Whilst drought impacts are expected to increase, particular concern is the failure to provide adequate quantity and quality of water to 1.5 million people of the Valencia Metropolitan area.

Partnerships evolvement in the Jucar River Basin District

The diminution of vulnerability to drought has been an objective of planning activities and infrastructures development ever since the creation of the first partnership in the region - the Jucar River Basin Partnership (1936) – yet past drought episodes have mostly been managed in a reactive manner.

As a result and since 2000, the Spanish water law requires developing Special Drought Plans (SDP) to transform the traditional reactive drought management approach into a proactive one. Alongside the SDP, a public-private partnership was established to decide upon measures and actions to mitigate the impacts of drought, the Permanent Drought Commission (PDC).

But this multi-stakeholder partnership requires a harmonised vision of the water necessities and accurate mitigation measures to act preventively. It also needs adequate risk information, on which basis it has to decide to re-allocate or prioritise water supply when it becomes scarce.

Working within the existing partnerships, ENHANCE fosters the collaboration and common understanding of all stakeholders through workshops and dialogues with the aim to contribute to a better integrated and interrelated drought management.

To further support the stakeholders, the project aims to provide them with **improved hazard and risk assessments as well as instruments for risk reduction**, reviewing the weaknesses of measures put in place during past events.

Partnership & Case study - State of play

- The Jucar River Basin Agency (CHJ), a public multi-sectorial partnership for the management and operation of all the water bodies within its territory and competences, is in charge of the system during normal weather situations. During drought emergency situations, the Permanent Drought Commission (PDC), a public-private and multi-sectorial partnership, gathers and looks for measures and actions to mitigate the impacts of the drought episode.
- Within the PDC, each representative is listened to on a similar basis and decisions are usually made via consensus. The participants have access to all the existing data and analysis regarding the risk and the effects of the different measures studied.
- A Royal Decree from the Nation Government grants the PDC additional competencies and special powers leading to a better management during the drought episode.
- The Drought Special Plan of 2007 includes as a requirement that a Drought audit is carried out once a drought episode ends. This audit is meant to detect the gaps and needs for the proper management of future droughts.
- The use of Decision Support Systems, such as the ones developed with AQUATOOL, has a very important role in the decisions made by the partnership since their results give the stakeholders a good perspective of the problems addressed and allows common understanding of everyone's issues. It also helps to find response to drought problems.

“ Droughts do not always occur under the same conditions, neither socio-economic nor hydrologic.“

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Facts and figures

- Major modern history droughts in the Jucar River Basin District happened in 1983-1986, 1992-1995, 1998-2000 and 2005-2008;
- It is foreseen that extreme droughts will occur more often and with potentially catastrophic outcomes;
- Direct impacts of droughts concentrate currently mainly on agriculture and hydroelectricity.

Stakeholder involvement

- Various farmer organisations (irrigation)
- Area metropolitana de Valencia (urban and industrial water supply)
- City of Albacete
- Iberdrola S.A. (hydropower)
- Xuquer Viu and ADIMAN (La Asociación para el Desarrollo Integral)
- Ecologistas en Acción (NGO)
- Confederacion Hidrográfica del Júcar
- Unidad Sindical de Usuarios del Júcar (USUJ)
- Hydrola power

3.5 UK Flood risk and insurance implications for MSPs

In the early 2014 the UK was affected by severe weather causing a widespread flooding across the country. The impact on individuals, businesses and infrastructure was substantial. Flooding is recognised as UK’s most common and costliest natural hazard, and its potential impact should not be underestimated, particularly in low lying areas, such as the Thames, the Severn and the Humber. London itself is highly vulnerable. In fact, the future flood risk is expected to increase due to urbanisation and population growth, climate change, and the deterioration of the flood defence system.

ENHANCE investigates two very different existing partnerships: the UK flood insurance scheme, which is based on partnership between public and private sector; and the London Climate Change Partnership (LCCP). Under both these strands, the project aims to explore and understand the:

- Relative merits of household and community risk reduction measures;
- Optimal levels of risk and risk reduction from different stakeholders’ perspectives;
- Interaction of stakeholders;
- Role of different MSPs and economic instruments in delivering risk reduction;
- Role of asymmetries in information and uncertainty in stakeholder decision-making.

Moving on from ‘Gentleman’s Agreement’ to ‘Flood Re’

The UK is currently transitioning towards a new flood insurance arrangement between government and industry. ‘Flood Re’ was put in place following the end of a public private partnership arrangement between UK government and the insurance industry, known as a ‘Gentleman’s Agreement’ or Statement of Principles. Unlike the initial agreement, where the insurance was entirely underwritten by the private market in exchange for government committing to flood risk management activities, the new approach is build around a not-for-profit pool termed ‘Flood Re’ for high risk households. ‘Flood Re’ will be run by the insurance industry, but government maintains some involvement. ENHANCE explores the two approaches to flood insurance in the context of the ability to incentivise risk reduction.

We use an established analytical framework methodology to understand if and how the flood insurance partnerships respond to the challenge of rising risk levels, with a focus on risk reduction.

The LCCP - a climate partnership for London

London itself also benefits from local partnerships such as the London Climate Partnership (LCCP), a long-running initiative to address climate risks within an urban environment. We focus on this case study as a means to understand broader stakeholder engagement and specifically as a lens to explore a public-private partnership. The LCCP provides a counter-point to the insurance partnerships and helps us to assess if and how partnership structures can be used to address risk in London.

This work is undertaken in collaboration with the University of Oxford and combines qualitative as well as quantitative assessments. Under the qualitative strand of this study we develop a survey and conduct semi-structured interviews to investigate the role and understanding LCCP members have within the partnership in addressing both climate and flood risks in London. The quantitative assessment is being facilitated through the development and implementation of an Agent Based Model (ABM), to assess insurance-related instruments; the behaviour between, and motivations of, different stakeholders involved in the risk sharing arrangement; and mechanisms to enhance resilience.

Looking into the existing MSPs and the new insurance 'Flood Re' scheme, ENHANCE is able to explore their influence on London's resilience to major flood risks today and in the future.

Partnership - State of play

Flood insurance:

- ENHANCE partners conducted analysis of the prevention/risk reductions elements in both existing and new schemes. It triggered stakeholder dialogue to feed the on-going debate.
- ENHANCE intervention led the Government amending the feasibility calculations (Impact Assessment) to reflect on climate change as a risk driver.
- Informing current process of operationalising 'Flood Re' with the aim to incorporate risk reduction measures.

LCCP

- ENHANCE partners conducted survey of members and presented interim findings at LCCP-meeting;
- The findings led to a debate on how to measure'impact'of a partnership – members have diverging perspectives on this.
- Our investigation revealed several key themes relating to barriers and opportunities facing the LCCP: the role of funding and regulations; the partnership longevity; range of partnership functions from rhetoric to reality; and partnership dynamism in responding to changing risks and needs. The ENHANCE project is now reflecting critically on each of the key themes.

Facts and figures

- Flooding is recognised as UK's most common and costliest natural hazard;
- London is vulnerable to tidal, river, surface water, sewer and groundwater flooding;
- A 1/200 year rainstorm in London, for example would cause surface water flooding that could flood 680,000 properties;
- The largest MSP in scale is the partnership between the UK government and the insurance sector.

Stakeholder involvement

- Greater London Authority (GLA)
- Department for Communities and Local Government (DCLG)
- Department for Environment, Food & Rural Affairs (Defra)
- Environment Agency (EA)
- Hydrometeorology Testbed (HMT)
- Local authorities (London Boroughs)
- Association of British Insurers (ABI) and members
- Reinsurers (such as Munich Re)
- Brokers (such as Willis)

"Adaptation by societies and economies alone is not considered to be sufficient to address the complexity, range and magnitude of risks and opportunities associated with climate change (EEA, 2014)."

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3.6 Flood risk management for Rotterdam port infrastructure

Europe's geography is ideal for maritime activities, with over 70,000 km of shores Europe counts for 1,200 commercial ports with direct and indirect positive impacts on jobs and growth. Yet, significant changes in climate already have an impact and increasing temperatures, rising sea level, changing river discharges, as well as more intense and frequent extreme weather events require substantial adaptation and risk management strategies.

Between 1998 and 2009, Europe witnessed over 213 major damaging floods, causing around 1,150 deaths and forcing half million people to move. Overall, floods caused more than €52 billion in insured economic losses, making floods the most costly hazard faced by Europe.

Inclusive adaptation strategies

The port of Rotterdam is located on relatively high grounds and until now it has been safe against storm surge floods. However, due to sea level rise, future storm surges may severely impact Europe's largest port infrastructure with, among others, large economic, societal, and environmental consequences and calls for a substantial stakeholder dialog for an inclusive decision-making process.

The multi-sector partnership is currently composed of the Province of South-Holland and the municipality of Rotterdam. Formally, this partnership is not responsible for flood protection of unembanked areas, but it does decide upon the design and implementation of flood protection and adaptation strategies. Yet, other public and private actors (land owners and business in the port region) are directly affected by the measures taken with only little influence in the decision-making process while often bearing responsibility of flood protection and resulting costs.

ENHANCE intervenes to:

- Develop a quantified approach for assessing flood risk in terms of societal disruption due to storm surges in the port of Rotterdam industrial areas;
- Map risks and analyse flood impacts and allow information to be shared between different players;
- Raise awareness of private sector on flood risks by using better communication tools and break the communication gap.

Enhancing the current MSP leads to balanced decision-making and contributes to consensus and increased transparency. Furthermore, exchange of views can lead to a coherent and holistic flood protection strategy for outer dike areas in which involved parties know their responsibilities and are aware of the consequences of a flood.

“Overall, floods caused more than €52 billion in insured economic losses, making floods the most costly hazard faced by Europe”.

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Partnership - State of play

- The Province of South-Holland and the municipality of Rotterdam control outer-dike developments. However, they are not responsible or liable for possible consequences resulting from floods. To create a balance in the decision-making on outer-dike flood protection between private and public participation, involvement of other stakeholders is recommended.
- To establish a balanced partnership the vicious circle between lack of awareness, lack of information and lack of communication needs to be broken. Lack of awareness arises since The Netherlands is regarded as safe from flooding. Due to an information deficit, potential consequences are not known and insufficient communication causes businesses to be unaware of the implications and possible consequences of living in an outer dike area. This again strengthens the lack of awareness.
- Workshops are organised to explore new partnerships and possible protection strategies. In the short term, the aim is to open the dialogue, improve communication, and build trust between the stakeholders. At a later stage, the aim is to build a partnership focusing on the preferred strategy for outer dike flood protection.
- In order to decrease the information deficit, a quantified approach has been developed for assessing flood risk in terms of economic losses, failure of infrastructure and societal disruption. The results of several protection strategies will be discussed in the workshops.

Facts and figures

- Between 1998 and 2009 Europe suffered over 213 major damaging floods;
- 1998-2009 floods caused 1126 deaths and displaced around 500.000 people;
- €52 billion in insured economic losses were caused by the 1998-2009 floods;
- Port of Rotterdam faces increased risk of flooding due to sea level rise and changing river discharges.

Stakeholder involvement

- Province of South Holland
- Municipality of Rotterdam
- Port of Rotterdam Authority
- Safety region Rotterdam
- Rijkswaterstaat - the executive body of the Ministry of Infrastructure and the Environment in the Netherlands
- Private companies
- Insurance sector

3.7 Health preparedness and heat wave response plans

In the summer of 2003, Europe was hit by an extreme drought and heat wave with severe consequences. The warm period began in June and continued through August, when the temperature was 20 to 30 % higher than the seasonal average across a large area of the continent. Temperatures of 35 to 40 °C were recorded in a number of European countries and resulted in more than 30,000 people dying due to this the extreme heat. Among all countries, France reported the highest number of casualties reaching approximately 14,000.

Apart from the loss of lives, the disaster had economic and environmental effects such as destruction of large areas of forests by fire and effects on water ecosystems causing power cuts, transport restrictions and decreased agricultural production. Estimated losses accounted to approximately €13 billion.

Preparedness and response to future events

From this event, Europe emerges as a geographic area responsive to high temperature and, due to climate change, a further increase in frequency, intensity and duration of heat waves is predicted. Therefore, a growing need to improve governance mechanisms, such as revisited health partnerships, is needed to support risk reduction activities to extreme period events.

Through existing examples of multi-sector partnerships in health in a number of selected countries, the **ENHANCE partners will propose a tool to increase health resilience to extreme heat events.**

The scope of activities includes:

- Analysing the different partnership roles to identify good practices on how to better integrate a range of actors within the topic of extreme heat events and health in a number of selected countries;
- Tackling already identified gaps such as the need to improve cooperation between health and social care actors;
- Development of improved hazard and risk assessment information;
- Overall, the project responds to the need to qualify and characterise the burden of heat-related human health problems with specific information on morbidity and past mortality cases, and then feed this critical information into multi-sector partnerships to improve heat planning and risk reduction activities in Europe.

“Stakeholder partnerships, and roles they can offer as a tool to increase health resilience, are a neglected area of both disaster studies and public health research.“

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Case study - State of play

ENHANCE partners have identified and focus on three locations within the case study:
- Amsterdam (NL);
- Brussels (BE);
- London (UK).

In each location, they undertake interviews with persons involved in extreme heat events and health, and carry out an epidemiological study on the relationship between extreme heat and morbidity.

In the case of Amsterdam, the interviews have been finalised. For the other locations, first contact has been made with key experts. In addition, first ideas for epidemiological studies have been discussed with local experts.

Facts and figures

- In summer 2003, Europe was hit by a heat wave, with temperatures 20 to 30% higher than the seasonal average;
- The 2003 heat wave caused 30,000 casualties (14,000 in France);
- The overall estimated losses accounted to €13 billion.

Stakeholder involvement

- World Health Organisation (WHO) Europe (Bonn)
- European Environmental Agency (EEA)
- Civil protection or other disaster response agencies
- Decision makers related to health policies, managers of health structures
- Members of confederations representing relevant private partners

3.8 Insurance and forest fires resilience

Each year forest fires impact European lands. Extreme weather conditions with very low humidity and high temperature result in very high intensity wildfires. Not only are forests and the biodiversity in general in danger, but also smoke intoxication causes deaths or major health problems for inhabitants and animals whilst destroying facilities and infrastructure such as houses, grid infrastructures and roads. In Portugal, the Santarém district was one of the most affected region with large burned areas before 2006. Taking the sole example of 2003, 87, 000 hectare of forest and scrubland were blown away, people were killed, livestock lost and houses burnt down.

In response to these forest fires, the Portuguese government set up public-private committees with the aim of articulating all means of action, from fire prevention education, surveillance, detection, supervision, first intervention, fire fighting, mop up actions, and post forest fire surveillance. While public authorities commonly take care of the coordination, the private sector and local governments implement the actions. The result of these multi-sector and inter-communal partnerships is largely positive with a decrease of large and big impact wildfires.

Improving further forest fires management

To further improve the forest fires management, the **ENHANCE project partners currently investigates how committees would react to a similar 2003 forest fire scenario** and how well prepared the partnerships are in increasing resilient communities.

ENHANCE pays particular attention to wildfires resilience and how the partnership can be extended to benefit the society against current and future wildfire threats. It aims at providing knowledge and tools to:
- Understand the fire prevalence and how risk assessment can be improved;
- Choose which economic instruments, insurance and forest certification bodies, are best to contribute for a better forest management and mitigation actions;
- Engage with the community to increase wildfires perception and stimulate societal control.

By providing in-depth risk assessment tools and analysing economic instruments and strategies for forest management, ENHANCE contributes with both scientific and hands-on knowledge to reduce wildfire risk and its impact.

Partnership - State of play

- The ENHANCE project analysed the healthiness of the existent partnerships among the municipal commission of forest fire defence of Mação and Chamusca (included in the Santarém district), within the framework governance and risk management. Following the 5 capitals approach, the partners realised that all the capitals are present. However, there is a deficit in terms of financial capital and environmental capital.
- The project is conducting an assessment of the several reasons why private insurers have difficulties in offering forest fire insurance at low cost. One of the most important difficulty is the lack of useful and understandable information about the diverse forest areas and wildfire risk.
- Partners are currently analysing how the data for insurers can be more effective and useful, simultaneously with the final analysis of the governance for the two municipal commissions included in the study case.

Facts and figures

- District of Santarém is one of the most affected regions by wildfires in Portugal;
- In 1991 almost 35,000 ha, in 2005 45,500 ha and in 2003 87,000 ha (the worst recorded wildfire since 1975) of land were burned in the region;
- The impact of wildfire can be considerable for humans, capitals, and flora and fauna;
- In 2009 Intermunicipal Commission for Forest Defense (CIMDFCI), consituted by public and private institutions, was created.

Stakeholder involvement

- Municipality of Chamusca and Municipality of Mação
- Civil Protection Authority (CPA)
- ACHAR (landowners association)
- Altri (Pulp & Paper)
- Chamusca's Firefighters Corporations
- DRF-LVT (Regional Forest Services)
- Civil Protection Authority
- Empremédia (Insurance company)

"Although partnerships are no 'one-size fits all' concept, learnings from Santarém can be transposed and adapted in other European Union regions."

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3.9 North Sea / Wadden Sea storm surges – risk, perception and management

For centuries, the Wadden Sea Region (WSR) has attracted humans to settle, develop towns, agriculture and business, or simply spend leisure time in a now recognised UNESCO's World Heritage site. Over the time, the area along the Wadden Sea became one of the world's most modified sea coastlines thanks to a continuous effort to claim land.

In this historical fight against the sea, the WSR has been at risk to flood hazards. The 100,000 casualties of 1362 as well as the 1717 Christmas floods that killed over 11,000 people persist as demonstrations of potential risks the area is facing. Flood protection levels have been raised due the experiences from disastrous flood events like in 1953 and 1962, and during the recent decades the dikes have proved to be effective against floods. However, projected future sea level rise and changing precipitation patterns aggravate the risk of floods along the North Sea coast in Europe. All in all, the area remains vulnerable to flooding and is in need of a comprehensive coastal risk management.

Yet, risk management is highly dependent on how individuals and groups perceive risks. The WSR is characterised by governmental top-down decision-making coupled with engineering protection measures. Hence, stakeholders and society are likely to shift the responsibility for improved coastal protection away from their own engagement.

Integrative coastal risk management

The ENHANCE project aims to introduce the topic of integrative coastal risk management with the objective to overcome obstacles and raise awareness towards a variety of risks, including flood risks, and their cascading effects. The intention is to initiate an exchange of knowledge and to provide a basis for further collaborative risk management on a cross-border level in cooperation with the existing multi-sector partnerships, composed of public and private actors within the Wadden Sea Region.

Thanks to upgraded risk scenarios of climate induced changes; qualitative scenarios in form of narrative visions, based on risk perceptions amongst institutions and sectors; and cross-national individual online survey, the **ENHANCE project facilitates a discourse about shared responsibility and cooperative practices in order to address the increasing sea-level rise and storm surges in the Wadden Sea Region.** Hazard risk profiles, policy strategies, and stakeholder cooperation offer the tools needed for risk reduction management.

"Risk management is a process to ensure that we identify and understand the risks; and, that we manage the risks according to the identified needs and concerns not only of the people involved in the process but as well of the society at large. If storm surges protection is considered to be in good hands, storm surge management is not perceived as burning issue."

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Case study - State of play

- In a series of workshops with the members of the trilateral Wadden Sea Forum, partners of the ENHANCE project addressed the integrative perspective of risk management, incorporating the perception about risk, the vulnerability of the regional population, the sensibility of private stakeholders and the potential of cross-national cooperation. The goal is to sensitize for risk management as a social process rather than a purely technical endeavour.
- Along with the workshop series, partners undertook an online-based, personalised risk awareness survey in the communities along the Wadden Sea Coast.

Facts and figures

- The area of Wadden Sea has been at risk of flood for centuries (1362 - North Frisia was almost wiped away; 1717 - floods caused widespread destruction in the Netherlands, Germany, and Denmark);
- In 1953 and 1962 - the latest fatal disaster took place in the area;
- Storm surge events cause losses of lives, livestock and land.

Stakeholder involvement

- Trilateral Wadden Sea Forum
- Landesbetrieb Küstenschutz, Nationalpark und Meeresschutz Schleswig Holstein (LKN)
- Niedersächsischer Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz (NLWKN)

3.10 Testing the solidarity fund for Romania and Eastern Europe

The longer it takes to recover from natural disasters the deeper and more widespread their effects are. Since 2002, the European Solidarity Fund (EUSF) supported countries faced with catastrophic events for an amount of over € 3.7 billion over 63 disasters. The governmental aid strongly differs across EU countries and many of them cannot cope with the consequences of disasters on their own.

Yet, with compensation restrictions for non-insurable public losses as well as its fixed budget, the EUSF has to limit the financial assistance provided leaving countries that take few preventive measures exposed to higher risk due to increasing occurrence of natural disasters.

Extreme events such as floods and earthquakes therefore present vast financial risk to both private actors and public authorities with potential governmental uncertainty when compensation measures are insufficient.

In Romania, where a large area of the country is under high risk of flooding, the authorities are only partially prepared to face natural catastrophes. The main reasons are related to financial and human capacities. The country has thus become a common claimant of the EUSF resources. The fund is considered an important tool of recovery in the country, even though it should only act as an extra layer of funding and not as a complete post disaster support.

Strengthening and refocusing the EUSF

While the 2014 EUSF reform responded to some weaknesses, the **ENHANCE project seeks to further strengthen the EUSF and Multi-sector partnerships (MSPs)** by:

- Refocusing current transnational MSPs to increase the general coping capacity of national governments with extreme events;
- Reorienting the EUSF from a post-disaster response and aid instrument to a pre-disaster, risk-based solidarity instrument;
- Investigating the probability of EUSF to reach its limits;
- Providing improved sources of information to stakeholders, improving their knowledge of the risks they face.

“ Re-orienting the EUSF from a post-disaster response and aid instrument to a pre-disaster, risk-based solidarity instrument.”

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Partnership & Case study - State of play

- The project provides detailed flood loss estimations for both Romania and the EU;
- Partners have conducted a number of interviews with stakeholders including representatives of national and regional risk pools and other insurance companies;
- In January 2014 the preliminary findings of the case study were shared with European policy makers at a the occasion of a public hearing;
- Romanian stakeholders discussed disaster risk financing at a workshop organised by the Bucharest University of Economic Studies and IIASA in October 2014;
- Case study partners will further assess disaster risk financing at the EU level by inviting key stakeholders to a workshop to be held in Brussels in the course of 2015.

Facts and figures

- 1,028,000 ha of land and 928,935 people in Romania are at high risk of flooding;
- EUSF provides assistance to recover from natural disasters causing damage of at least € 3 billion (in 2011 prices) or 0.6% of gross national income (GNI) of the country;
- EUSF compensates only non-insurable public losses;
- Value of insured losses could increase by 250% by 2050.

Stakeholder involvement

- The United Nations Office for Disaster Risk Reduction (UNISDR)
- Perspectives GmbH, Hamburg
- European Commission’s Directorate General for Regional and Urban Policy (DG REGIO)
- European Commission’s Directorate General for Climate Action (DG CLIMA)
- World Bank

4. Flood Insurance: Recent findings of the ENHANCE project*

Floods are one of the most wide-reaching and commonly occurring natural hazards in the world, affecting on average about 70 million people each year (UNISDR, 2011). Due to socio-economic factors such as urbanisation and population increase, loss costs trends are rising while climate change is also expected to exacerbate the impacts of flooding (IPPCC, 2012, 2014). Therefore, the prevention role of insurance has received renewed attention due climate change induced risks: How can risk transfer reduce today's and future climate risks – not just in financial terms, but also with regards to the underlying physical risks, as a tool to help individuals, communities and countries to adapt to a changing climate?

Looking at current evidence from the literature and the market, the answer to this seems to be 'yes in theory, not really in practice'. Surminski and Eldridge (2014) concluded that the existing and newly proposed flood insurance schemes in England offer very limited scope for physical risk reduction. One aspect that warrants further investigation is the role of other stakeholders, whose action can determine future risk levels. The most relevant group are property developers, and there is a wider range of stakeholders in the development process, from the concept of a building to actual delivery on the ground.

There is ample evidence that insurance, or risk transfer in general, can boost resilience to natural hazards more (effectively) than ex-post disaster aid (e.g. Ranger et al. 2011). Insurance can reduce financial burdens and uncertainty (Ghesquiere and Mahul 2007; Melecky and Raddatz 2011), and assists economies in dealing with the negative long run impacts of natural hazards such as flooding (von Peter et al. 2012). Risk pricing may encourage reduction of exposure and lead to lower damage costs (Bozzola 2014). Yet, on the other hand, poorly designed insurance products and ill-structured insurance markets can drive economic inefficiency and maladaptation to future risks (Surminski 2013).

In order to investigate further how insurance and disaster risk reduction could be better linked and what role insurance partnerships can play, the ENHANCE project is following a three-tiered approach:

- a **review of the current knowledge on insurance and disaster risk** reduction linkages, with a special focus on flood insurance (Surminski 2014) and EU policy making (ENHANCE workshop in 2013, Surminski et.al - forthcoming in Natural Hazards);
- the development of **six methods** to investigate the insurance and disaster risk reduction linkages (Deliverable 5.3 – forthcoming); and,
- the reflection on insurance and disaster risk reduction across different **case studies**.

The rapid increase in global economic losses from floods has re-intensified discussions among private insurers, governments and the EU about the role of insurance in addressing flood risk in England. Key aspects in this debate are the affordability of cover, the availability of private insurance, and the implications for risk prevention measures, and the roles of government as regulators.

There are several reasons why private insurers have difficulties in offering flood insurance at low cost: it is difficult to estimate uncertain extreme events; in many areas flood risk information is still very limited; flood losses are volatile; capacity to cover potentially large and correlated natural disaster losses can be limited. Public insurance schemes, which are controlled by the Government, often face solvency problems, creating large public liabilities, and diverting financial resources away from other important public projects.

In addition, all approaches to flood risk transfer face the challenge of moral hazard. This is particularly relevant in the context of rising risk levels, where the question of how to link risk transfer to risk prevention may determine future insurability.

Across the European Union (EU) a wide range of flood insurance systems exist, from private market solutions to public flood insurance schemes. The European Commission (EC) has instigated a debate on what the role of the EU should be in the context of disaster insurance in Europe. A Green Paper on disaster insurance, published in summer 2013 (EC COM (2013) 213), builds upon existing evidence to produce insights that can guide potential actions by regulators, industry or policy makers at a European level to increase market penetration. Possible options discussed in the Green Paper include mandatory insurance, product bundling, public reinsurance or disaster pools.

While the question of supply and demand is at the core of the debate, partners of the ENHANCE project argue that another key dimension is often overlooked: how to use insurance as a lever for risk reduction and prevention efforts. The project explored if and how current EU policies interplay with these two dimensions. In analysing the current positions on the role of the EU in shaping flood insurance it concludes that there is wide agreement that harmonisation of flood insurance offering across the EU is unlikely to be effective. There is clear scope for the EU to play a greater role in linking risk transfer and prevention, beyond existing channels, to ensure an integrated approach to flood risk management across the EU.

Conclusions from those ENHANCE activities can be summarise as follows:

Action is needed to maintain affordable insurance

- Member states must implement National Disaster Risk Reduction plans, to reduce risk, and to keep premiums low.
- Risk awareness should be raised amongst all stakeholders. This increases insurance penetration rates, and stimulates implementing risk reducing measures.
- Insurance can provide incentives for individuals to implement risk reducing measures.
- However, this requires a well-designed insurance scheme, with risk based premiums, and targeted information provision about flood damage mitigation measures.
- Public funds should be used to pay for investment in flood risk prevention, i.e. flood defences, or as an incentive for households to more actively manage their own flood risk.
- Public funds must not be used to subsidise insurance premiums or state led compensation programmes. This leads to moral hazard.

EU Solidarity Fund (EUSF) fails for Stress test

- EU flood risk is set to increase from currently €4.9 billion a year to €23.5 billion a year in 2050. 30% of this increase is due to climate change (see manuscript of the ENHANCE team in 'Nature Climate Change' attached).
- Amidst the projected increase of the current allocation of the fund (€500 million in 2011 prices), the EUSF will not be able to to provide adequate aid for disaster stricken countries.
- Substantial risk reduction is necessary, which is feasible through stimulating flood protection investments, at positive benefit/cost rates in many regions.
- Residual risks can be covered to a larger extent by increasing insurance penetration or turning EUSF into a European risk sharing facility.
- Mobilisation of the aid from the EUSF should be accompanied with mandatory risk reduction measures by governments after pay-outs have been made, to a larger extent than foreseen by the 2014 reform of the Fund.

Towards public-private partnerships (PPPs) in Insurance

- New public-private-partnerships (PPPs) for flood insurance are needed in EU member states, starting with outlined clear responsibilities in DRR, providing incentives and compensation schemes.
- PPPs should start sharing information between governments and insurers on risk modelling.
- Member states need to develop systematic and harmonized risk mapping and risk projections.
- Information is needed regarding the costs and benefits of flood prevention, in order to set priorities form investment programmes in member states.

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• ENHANCE publications

Parallel to the case studies based activities, ENHANCE developed a series of thematic cross-studies to enhance society's resilience to catastrophic natural hazard impacts. These are available on **www.enhanceproject.eu**

1. **Catalogue and toolbox of risk assessment and management tools** (2014), Anna Timonina (IIASA), Reinhard Mechler (IIASA), Keith Williges (IIASA), Stefan Hochrainer-Stigler (IIASA).

2. **Conceptual guidelines for case studies** (2013), Laurence McLean (UCL [1]), Peter Heudtlass (UCL), Debby Sapir (UCL), María Máñez Costa (HZG), María Carmona (HZG), Kira Gee (HZG), Birgit Gerkensmeier (HZG), Beate M.W. Ratter (HZG), Wouter Botzen (IVM), Jeroen Aerts (IVM), Paul Hudson (IVM), Ted Veldkamp (IVM), Reinhard Mechler (IIASA), Anna Timonina (IIASA) Keith Willeges (IIASA), Swenja Surminski (LSE).

3. **Developing a resilience framework** (2013), Laurence J. A. McLean (CRED), Debby Guha-Sapir (CRED).

4. **Development of MSPs in the Po River Basin District. Controlled floods on agricultural and scarcely developed rural land (MSP-F) and managing severe drought spells in the otherwise water-abundant river basin district (MSP-D)** (2014), Jaroslav Mysiak (FEEM), Lorenzo Carrera, Mattia Amadio, Dionisio Perèz Blanco (FEEM), Silvia Santato (FEEM), Cinzia Alessandrini (ARPA-ER [2]), Silvano Pecora (ARPA-ER).

5. **Governance indicators for (un)successful MSPs** (2013), María Máñez Costa (HZG), María Carmona (HZG), Kira Gee (HZG), Birgit Gerkensmeier (HZG), Beate M.W. Ratter (HZG), Wouter Botzen (IVM), Jeroen Aerts (IVM), Youbaraj Paudel (IVM).

6. **Increasing stress on disaster-risk finance due to large floods** (2014), Brenden Jongman (IVM), Stefan Hochrainer-Stigler (IIASA), Luc Feyen (JRC [3]), Jeroen Aerts (IVM), Reinhard Mechler (IIASA), Wouter Botzen (IVM), Laurens M. Bouwer (IVM), Georg Pflug (IIASA), Rodrigo Rojas (JRC), Philip J. Ward (IVM).

7. **Inventory of policy instruments and indicators for MSP-policy interaction** (2014), Jaroslav Mysiak (FEEM [4]), Elisa Calliari (FEEM), Dionisio Perèz Blanco (FEEM); contributors: Silvia Santato (FEEM), Swenja Surminski (LSE), Maria Manez Costa (HZG), Roger Cremades (HZG).

8. **Managing unnatural disaster risk from climate extremes** (2014), Reinhard Mechler (IIASA [5]), Laurens M. Bouwer (IVM [6]), Joanne Linnerooth-Bayer (IIASA), Stefan Hochrainer-Stigler (IIASA), Jeroen Aerts (IVM), Swenja Surminsky (LSE [7]), Keith Williges (IIASA).

9. **Reflection on the current debate on how to link flood insurance and disaster risk reduction in the European Union** (2014), Swenja Surminski (LSE), Jeroen Aerts (IVM), Wouter Botzen (IVM), Paul Hudson (IVM), Jaroslav Mysiak (FEEM), Dionisio Perèz Blanco (FEEM).

10. **Review of economic instruments in risk reduction** (2014), Michel Köhler (PCC [8]), Reinhard Mechler (IIASA), Wouter Botzen(IVM), Swenja Surminski (LSE), Manuel Pulido Velázquez (UPVLC), Antoine Leblois (JRC), Adriana Keating (IIASA), Junko Mochizuki (IIASA), Maria Manez (HZG), Roger Cremades (HZG), Jim Hall (UOX [9]).

11. **Risk perception and risk cultures in Europe** (2013), María Carmona (HZG [10]), María Mañez (HZG), Pino González- Riancho Calzada (HZG), Swenja Surminsky (LSE), Joanne Bayer (IIASA), Susanne Hanger (IIASA), David Haro (UPVLC [11]), Joaquín Andreu (UPVLC).

12. **The development of an extreme temperature MSP to mitigate related human health impacts in Europe** (2014), Laurence J. A. McLean (CRED [12]), Debby Guha-Sapir (CRED).

Access all publications online!

1. Université Catholique de Louvain
2. Agenzia Regionale Prevenzione E Ambiente Dell'Emilia-Romagna
3. Joint reseacrh Centre
4. Fondazione Eni Enrico Mattei
5. International Institute for Applied Systems Analysis
6. Institute for Environmental Studies
7. London School of Economics and Political Science
8. Perspectives Climate Change
9. Oxford University
10. Helmholtz-Zentrum Geesthacht
11. Universitat Politècnica de València
12. Centre for Research on the Epidemiology of Disasters

Glossary

This glossary includes frequently used terms.

Cost-effectiveness analysis (CEA) - is used to identify least-cost options to meet a certain target or policy objective (Timonina et al.2013).

Cost-benefit analysis - a decision-making assistance method that identifies the economically efficient way to fulfil an objective by comparing benefits and costs of two or more courses of action (Timonina et al.2013).

Disaster risk - the likelihood over a specified time period of severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions assets in places that could be adversely affected (McLean and Guha-Sapir, 2013).

Disaster risk management - processes for designing, implementing, and evaluating strategies, policies, and measures to improve the understanding of disaster risk, foster disaster risk reduction and transfer, and promote continuous improvement in disaster preparedness, response, and recovery practices, with the explicit purpose of increasing human security, well-being, quality of life, resilience, and sustainable development (McLean and Guha-Sapir, 2013).

Disaster risk reduction (DRR) - includes all the policies, strategies and measures that can leave people, villages, cities and countries more resilient to hazards and reduce risk and vulnerability to disasters (UNISDR, 2011).

Exposure - the presence of people, livelihoods, environmental services and resources, infrastructure, or economic, social, or cultural assets in places that could be adversely affected (McLean and Guha-Sapir, 2013).

Multi criteria analyses (MCA) - is a decision support approach. With an emphasis on low cost, the methodology is organised around objectives, criteria and indicators. Criteria are attributes, which can be used to compare the performance of different (policy) options in achieving stated objectives (economic, social, environmental and fiscal criteria). Indicators are verifiable measures, which can be used to monitor changes over time and space in the behaviour of the attributes. They can be expressed in quantitative (monetary or not) or qualitative terms (Timonina et al.2013).

Multi-sector partnerships (MSPs) - are voluntary but enforceable commitments between partners from different sectors (public authorities, private services/enterprise and civil society), which can be temporary or long lasting. They are founded on sharing the same goal in order to gain mutual benefit, reduce risk and increase resilience (Rhodes, 1997).

Resilience - is the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions (McLean and Guha-Sapir, 2013).

Risk perception - is the judgement about the characteristics and severity of the natural hazards risk using mental, rather than numerical models. Risk perception is shaped by cognitive, cultural and social factors and plays an essential role in judging if or if not to implement risk reduction measures (Timonina et al.2013).

Risk Assessment/analysis - is a methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend (UNISDR, 2011).

Vulnerability - the propensity or predisposition to be adversely affected (McLean and Guha-Sapir, 2013).

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Disaster through a different lens. Behind every effect, there is a cause. United Nations, Geneva, Switzerland.

Notes

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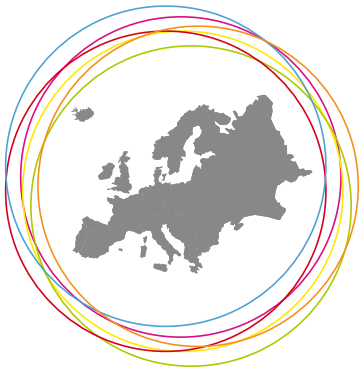
Partnership for Risk Reduction



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The ENHANCE project has received funding under the Seventh Framework Programme of the European Union under grant agreement No 308438