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Partnership for Risk Reduction

ENHANCE

Enhancing Risk Management Partnerships
for Catastrophic Natural Disasters in Europe

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Deliverable 5.1: REVIEW OF ECONOMIC INSTRUMENTS IN RISK REDUCTION

Title	Review of economic instruments in risk reduction
Author(s)	Michel Koehler (PCC), 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)
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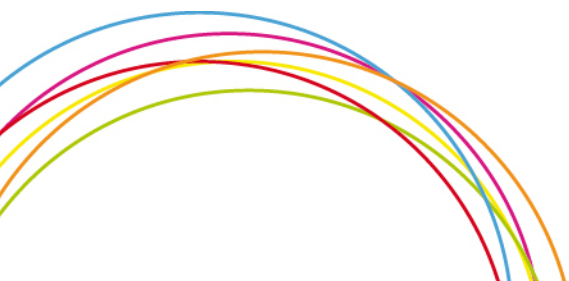


1 Introduction

Economic instruments (EI), such as subsidies, taxes and insurance-related options are at the heart of discussions regarding novel approaches for managing risk and adapting to climate change, including in the context of multi-stakeholder partnerships (MSP) between the private and public sectors (Agrarwala and Fankhauser, 2008; Bräuninger et al., 2011; Chambwera et al., 2014).

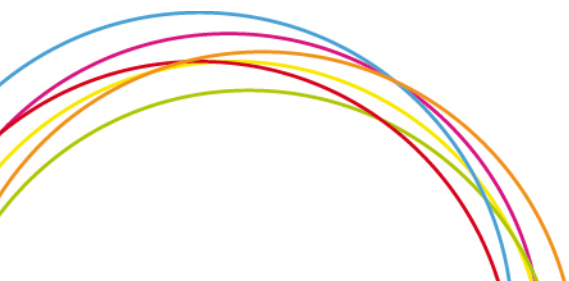
Although the attractiveness of reducing and managing disasters has long been demonstrated (e.g., Foresight, 2012), there is underinvestment into disaster risk management (DRM). A number of factors, such as lack of comprehensive information and cognitive biases are important. In particular, financial constraints and moral hazard, i.e. adverse incentives provided by current arrangements for dealing with disasters rule high (Chambwera et al, 2014). In this line of thinking, instruments that provide a price signal for risk management and incentivize behavioural change hold high appeal to policymakers including the EU (see Bräuninger et al, 2011). Yet, little is known about such economic instruments, their mechanics, links to risk management and concrete application in the field of disaster risk management (and climate adaptation) (see Chambwera et al, 2014. Knowledge gaps exist particularly for conditions that create enabling environments for innovative market based EI. Among these are, e.g., the attractiveness for stakeholders in the context of MSP or institutional settings that are required to successfully and efficiently apply the EI.

This report reviews key EI according to their potential for managing and incentivising risk management in the context of the ENHANCE project. The guiding questions for this review are:

- What economic instruments exist for managing disaster risk?
- How do they contribute to risk management?
- What innovative options re being discussed?
- How do case studies plan to discuss and assess economic instruments?

The overall aim of this report is to develop an inventory of EI as they support risk management generally and their anticipated uptake in the ENHANCE cases studies.

This report first discusses the methodology and the mechanics of EI. Next it presents the market-based and risk financing instruments; finally it concludes with a synthesis of our findings and next steps for the case studies, which are being carried out as part of the ENHANCE project.



2 Methodology

Figure 1 shows the main tasks underway in WP 5 of ENHANCE. This report refers to Task 5.1, where we assess the key methodological steps of the mechanics of EI in DRM, based on the available literature and a screening of anticipated uptake of the instruments in key ENHANCE case studies. The case study screening task is mainly conducted through a literature review and questionnaires submitted to our case study partners. The instruments with best suitability regarding risk management will be used for a short list of instruments that are further assessed ex-ante through, e.g., multi-criteria analysis and modelling. Instruments that are considered to be unsuitable for enhancing risk management will be excluded. This review lays the foundations for future work in the workpackage, where we will examine the instruments closely in terms of a number of criteria, such as ability to manage risk (initially discussed here), economic efficiency, equity and acceptability among others, as shown in the chart below.

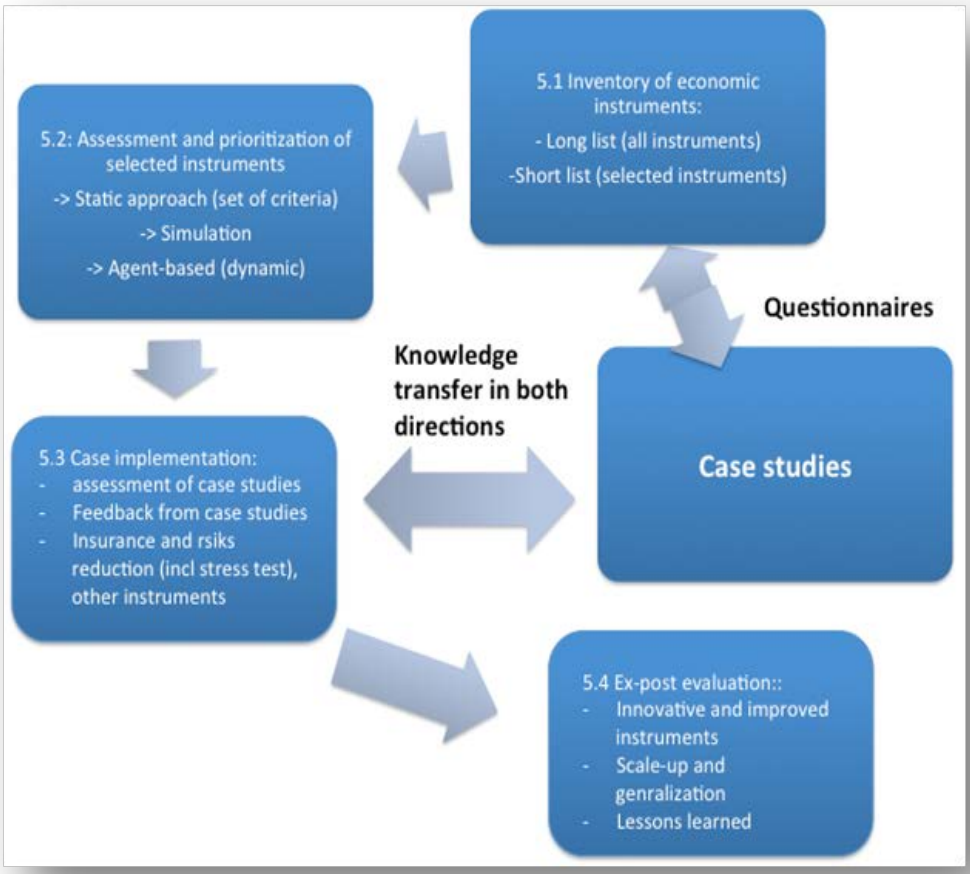


Figure 1: Workflow from Work-package 5

In order to identify case studies' focus and interest in this regard, a questionnaire exploring applied economic instruments in the case studies was devised and responses collected, which guaranteed coverage of all practically applied instruments in the long list. During the review phase, those partners responsible for certain instruments will get in further touch with the cases to provide input and enable exchange of information in both directions (case studies with WP5). These research tandems will also cooperate during the follow-up tasks 5.2 to 5.4.

The following steps have been applied for this report

- We first identify a long list of EI from the literature (what options can be found and what is the experience according the literature?)
- We examine which instruments are being used in the cases (based on a questionnaire submitted to case study partners). This guarantees that all applied instruments are reflected in our assessment.
- We analyse how the EI contribute to risk management (directly, indirectly or through systemic risk management) and describe the attractiveness for typical MSP stakeholders such as public and private actors or households.

2.1 Overview of instruments

Our overview focuses on the literature as well as the ENHANCE case studies' context.

3 Mechanics of economic instruments in risk management

Private and public sector agents are tasked with managing disaster risks. While massive efforts have been carried out throughout many regions for reducing and managing risk, there is good evidence suggesting that that all regions, sectors and societies are less than optimally adapted to current hazards and future changes therein, e.g. through climate change (Agrawala and Fankhauser, 2008; IPCC, 2014). In fact, as discussed in IPCC (2014) given a diverse set of risks and manifold preferences, constraints and perceptions of risk, there is no such thing as 'optimal' adaptation. Yet, there is ample scope for 'better' adaptation and risk management. Risk management may happen autonomously or through policy intervention and policy instruments-the focus of our attention for this report.

Apart from insurance-related instruments, few adaptation instruments work *directly* via economic principles and using markets to adapt to impacts and risks. On the other hand, economic instruments can be used to *indirectly* incentivise behaviour and increase the uptake and efficiency of adaptation measures. As one important reference, Agrawala and Fankhauser (2010) distinguish the following incentive-providing instruments relevant for key sectors:

- Insurance schemes (all sectors subject to extreme weather events),
- Price signals / markets (water; ecosystems),
- Financing schemes via PPPs or private finance (flood defence, coastal protection, water),
- Regulatory measures and incentives (building standards; zone planning),
- Research and development incentives (agriculture, health).

Synthesising this, and in line with recent literature, we consider two broad types of instrument categories (see also Chambwera et al., 2014; Bräuninger et al., 2011):

1. Market Based Instruments (MBI) are instruments administered by government regulators that provide a monetary/economic incentive promoting risk management and adaptation. According to the EU white paper, the definition of MBI is broad (see EU Commission 2009) and in the interpretation of this report it includes natural resource pricing, taxes, subsidies, marketable permits, payments for ecosystem services, licences, property rights and habitat banking.

2. Risk Financing Instruments (RFI) comprise all instruments that promote the sharing and transfer of risks and losses. They generally can be classified as pre-disaster arrangements, and comprise insurance, weather derivatives and catastrophe bonds.

In addition to MBI and RFI, financial instruments and public-private partnerships have been considered as economic policy instruments as well, yet will not be examined further by us. Financial instruments comprise of all sorts of support mechanisms that allow actors an enhanced access to capital. Among these are primarily loans, sometimes blended with grants, guarantees and equity investments. The EU has numerous financial instruments at its disposal ranging from loans, sometimes combined with grants, through guarantees to equity investments. In general, the focus of the policy measures is to just provide a line of funding to a certain investment, so there is now specific effect for managing risk. Yet, as many measures have a grant element, the instrument can be considered under the category of

subsidies. Public Private Partnerships generally refer to contracts including the allocation of liability between public and private entities for implementing infrastructure (see Akintoye, Beck and Hardcastle, 2003). In this sense, they are not of relevance for the economic instruments, but hold appeal for the discussion of regulation in WP 6.[1,2]

Three channels through which EI can contribute to risk management can generally be identified (see Bräuninger et al., 2011; Chambwera et al., 2014).

1. Direct risk reduction: as one example, risk financing provides direct compensation payments which reduce follow-on impacts from an event.
2. Indirect risk reduction: incentives for risk management and increased resilience help to reduce and manage risks.
3. Managing systemic risk: both down-and upside risk are managed, i.e. insurance takes down-side ("bad risks") risk out of investment decisions, which overall focus on harnessing upside risks ("good risks").

Our inventory is presented in the form of a long list (see table 1) and reflects instruments applied in the case studies. The EI are split up into the key groups mentioned above (see also Bräuninger et al., 2011).

3.1 Screening EI in the Enhance case studies context

The following table summarizes the interaction on EI with the case studies.

[1] In a wider sense, Public Private Partnerships have been used synonymously to denote the process of arriving at multi-sector partnerships, rather than implementing specific policy instruments, the focus of the ENHANCE project overall.

[2] Finally, while a discussion of regulation is key for economic instruments, regulatory policy instruments and implications are not covered within the context of this report as they are addressed by research in parallel work package 6, and further work in workpackage 5 will integrate findings from workpackage 6.

Table 1: Overview of economic instruments

Economic instrument	Description	Case study application
I. Market based instruments		
1. Subsidies	Subsidies can be defined as a financial support/incentive from a government to an entity for implementing a practice or performing a specified action.	• Rotterdam (tax reductions for steering companies) • Chamusca (Grants for remove burned cork from trees)
• **Grants**	Direct payments or grants constitute the purest form of a subsidy. An economic entity receives an amount of money which is supposed to induce the recipient to undertake a specific action bound to that payment.	• EU heat wave (Grants can incentivize retrofitting of buildings) • EU SDF (subsidies or tax reductions for certain insurances) • Jucar (water fees reductions to water users during sustained drought period)
• **Price supports**	Price supports belong to the group of indirect subsidies although some direct payment is usually associated with them. In its most common form, the government defines a price floor for a good and pays the differential amount to the producers of the good as soon as the market price falls or is below this minimum level.	• Jucar water system (subsidised investments in water infrastructure; subsidised electricity rates for pumping; etc,) • Rotterdam (subsidized Joint Technology Initiative to limit water related risks) • Chamusca (subsidized Joint Technology Initiative for fire fighting)
2. Taxes and fees	Besides generating government revenue allowing public expenditures e.g. for a public adaptation policy, taxes can also be used to direct private behaviour towards a socially optimal behaviour.	• Po (mandatory land use charge) • Rotterdam (Government could provide higher safety against fees) • Chamusca (Fuel tax for funding permanent forestry fundsfire protection activities)
• **Land use taxes and fees**	Land use taxes –we understand them as a tax on land and buildings – represent a payment either for the land ownership itself or for its kind of use. Land use fees are similar in nature, but they would by definition require some type of service from the collecting (public) institution in return.	• Jucar water system [in this case, we have to consider water tariffs, environmental taxes and environmental charges (e.g. point-pollution charges for WWT discharges) (The two latter pricing policies are more related to water quality than quantity, which is the main focus of the CS] • German Wadden Sea: land owners protected by a dyke are bound to pay a tax (e.g. in Cuxhaven)
3. Licences, permits and variations	Environmental markets are based on the generation of demand for tradable units through regulatory decision. This demand then triggers the supply of units.	
• **Project based offsets**	A project-based adaptation offset could be generated by projects in regions where adaptation is relatively easy to generate, but where no governmental adaptation commitment exists.	
• **Market mechanisms**	The objective of an Adaptation Market Mechanism is to create a market that honours adaptation activities of private and public actors by setting financial incentives	

Economic instrument	Description	Case study application
• **Advance market commitment**	The government guarantees a certain income to the entity providing a desired activity, making this instrument comparable to a subsidy.	• Chamusca (premium for selling burned wood)
4. Other Market Based Instruments	These instruments specifically address the problem of overuse of natural resources, partially picking up some of the broader concepts, like taxation.	
• **Payments for ecosystem services**	As long as the benefits from changing the ecosystem instead of conserving it are larger, a payment would be needed in order to avoid e.g. conversion of forests to pasture.	• Chamusca (Payment for Ecosystem by WWF/Coca Cola)
• **Water markets**	An intensification of unevenly distributed water resources, together with increasing average temperatures, calls for the efficient use of scarce water supplies. Therefore, the efficient (and appropriate) pricing and trading of water (rights) is one of the key tasks for climate change adaptation.	• Po (water banking agriculture to urban) • Jusca (Water markets) • Jucar (temporary public acquisition of water rights in order to guarantee environmental flows and supply to downstream demands during drought periods)
• **Habitat banking**	Habitat banking aims at conserving the ecosystem services of land, including biodiversity. Credits are given for the creation, restoration and enhancement of habitats, while debits occur when ecosystems are unavoidably degraded or destroyed.	
II. Risk financing instruments	There are many instruments for dealing with the financial burden imposed by disasters. At the most general level, we distinguish risk financing from loss financing instruments. The important distinction is that risk financing is purchased/organized by persons or a community at risk purposefully and in anticipation of risk, whereas loss financing is arranged by people, governments and the state, often ad hoc, after an event.	
• **Insurance**	Insurance helps to finance losses caused by events induced by climate variability. Insurance is useful for adaptation in incentivizing and enabling and risk reduction as well as enabling recovery and economic development.	UK, Chamusca, EU/Eastern Europe/Romania/ Netherlands/Italy/Spain • Po (mandatory insurance, subsidized) • Rotterdam (might apply insurances) • Vulcano (EU catastrophic insurance for recovery) • Chamusca (wildfire forest insurance for associates; ESF used) • EU heat waves (Weather derivatives might quickly provide funds) • EU SDF (insurance, catastrophe bonds or weather derivatives could be used) • Spain/Italy drought insurance for agriculture

Economic instrument	Description	Case study application
• **Catastrophe bonds**	A catastrophe bond is an instrument whereby disaster risks are packaged (securitized) in the financial markets. The investor receives an above-market return provided a specified catastrophe does not occur during the contract, but sacrifices interest or part of the principal if the event does occur.	EU/Eastern Europe/Romania
• **Weather derivatives**	Weather derivatives are contracts where pay-outs are linked to physical 'triggers', e.g. number of days with temperatures below or above a specified threshold, or rainfall above or below a specified level.	Chamusca , EU/Eastern Europe/Romania

In addition, we see a number of interesting additional and innovative mechanisms that are worth exploring in the ENHANCE case studies. These include reconsidering the EU solidarity fund and studying partnership funding arrangements in the UK. These innovative instruments will be further examined and discussed in tasks 5.2-5.4 over the course of the project.

Table 2: Overview of additional identified instruments in the case studies

Economic instrument	Application of the instrument in the context of the case study? Please describe	Application of the instrument in the context of the case studies
Risk-based EU solidarity fund	Shifting from intergovernmental loss compensation (the solidarity fund) to a risk-based mutual sovereign insurance fund	EU/Eastern Europe/Romania
Private financing linked to co-benefits	'Partnership funding' arrangements for financing flood defences that are being vigorously promoted in the UK. Private contributions to the costs of flood defences are being sought: (i) private actors may be major beneficiaries of risk reduction and (ii) because construction of flood defences can bring co-benefits, e.g. urban regeneration and provision or retail opportunities.	UK case

4 Review of instruments: Market-based instruments

The review of instruments takes into account a short presentation of the instrument, discusses how the instrument is linked to risk management, demonstrates general experience and evidence, possible case study application as well as specific conclusions.

4.1 Subsidies

Presentation of the economic instrument

Subsidies can be defined as "direct payments, tax reductions, price supports or the equivalent thereof from a government to an entity for implementing a practice or performing a specified action" (Gupta et al., 2007). While subsidies have been criticised as an inefficient policy instrument that leads to rent seeking by interest groups and eventually reduces economic competitiveness through discouraging innovation and the adoption of adaptation measures if the risk is completely eliminated by the economic compensation (see Goodwin and Smith, 2013), public opinion and political decision makers have been more favourable to this instrument. Thus subsidies have retained an important place in the catalogue of public policy instruments. Subsidies could be used to induce any type of proactive adaptive investments and behavioural changes. The application is also thinkable for supporting reactive risk management such as post-disaster recovery or for managing systemic risks through e.g. insurances. In literature, subsidies are differentiated into direct payments and indirect payments, including price support (see Bräuninger et al., 2011). Common forms are direct payments in form of grants, tax reductions and price supports. Tax reductions could apply to direct personal taxes or to goods taxes.

The link of subsidies to risk management

In the following section we analyse whether subsidies can contribute to risk management and risk reduction. Three types of risk reduction and management are distinguished as described above.

<u>Direct risk reduction (i.e. risk financing provides direct compensation payments which reduce follow-on risk)</u>

Besides the moral obligation for engagement after a disaster event, economic recovery and safety of the population guide public policies. Subsidies in the form of direct payments or tax reductions can be used for direct compensation payments. There is a concern however that this creates risk of moral hazard as it reduces the incentive for sustainable preventive measures or proper insurance coverage against disaster damage. Nevertheless, disaster relief, recovery and reconstruction subsidies are common responses to disasters on both local and national levels (see Lal et al., 2012).

<u>Indirect risk reduction through incentives for adaptation and increased resilience (e.g. adaption measures)</u>

Improvement of e.g. infrastructure that aims at protection of economic activities from extreme weather events - such as the raising of dyke levels - does often not generate direct revenues. Therefore, it can be considered as a public good that suffers from a lack of an incentive – an investor cannot capture all the benefits. In such a situation, government may provide a subsidy that is sufficient to mobilize the investment, taking into account any revenues that the investor might be able to generate. Hereby direct payments play a key role but also indirect support through tax reductions or floor prices can trigger such indirect risk reduction. Thus in terms of preventive adaptation incentives subsidies can play a key role.

To encourage risk reduction or adaptation activities, households could be allowed to deduct relevant expenditures like those for insulation of buildings or greening of taxable income. Firms could deduct more than actual adaptation expenditure from profits. Goods taxes could be reduced if production costs increase due to adaptation measures. An example might be a reduced VAT for agricultural goods which are more resistant to climate change than others. This reduces prices for these goods and thereby makes their production more attractive. This implies that the more resilient good is preferred (see Bräuninger et al., 2011).

Managing systemic risk (up-and downside risks are managed at the same time)
Subsidies can support the financing of insurance through direct financial contributions to the insurance rates or tax reductions for the stakeholders that apply insurance. Tax reductions can be applied to either the purchase of insurance and/or the income from insurance payments when they are realised, as in the case of the United States below.

Experience and evidence

Direct payments (grants)

- Grants for preventive measures, Sweden: Municipalities may apply for grants for preventive measures against disasters which are not common or do not follow a slow incremental course.[3]
- Farm Ready program, Australia: Australian government initiative to improve productivity and help farmers manage climate change and climate variability through soft adaptation measures.[4]
- Funding program for private flood protection, Hamburg Port Authority, Germany: subsidizes protection infrastructures against floods and storm surges, mainly in industrial land uses not covered by the public flood protection system of the city of Hamburg.[5]

Tax reductions

Lunder *et al.* (2012) detail the tax provisions to assist with disaster recovery in Congressional legislation in the United States. The provisions all relate to the provision of tax reductions for victims, showing how the use of subsidies over negative taxes. Disaster victims are typically provided with a suite of tax reduction opportunities as they relate to disaster relief payments, insurance payments, casualty loss and capital gain from involuntary conversion of homes damaged by disaster.

Application in the context of Enhance case studies

Based on the feedback gathered in our questionnaire on economic instruments, we have been able to identify applied subsidies in the context of the Enhance case studies. The following list outlines current examples:

[3] Further information at: http://www.sweden.gov.se/sb/d/574/a/96002
[4] Further information at: http://www.daff.gov.au/climatechange/australias-farming-future/farmready
[5] Further information at: http://www.fphws.de/foerderprogramm.htm

Flood risk management for critical infrastructure in the Port of Rotterdam, Netherlands:
This case study develops guidance for hydro-metrological disaster risk management for un-embanked areas in the port of Rotterdam. Besides assessment of risks, the control and limitation of water related risks through enhanced flood resilience is a key objective. The guidance could be facilitated by the government through subsidies such as tax reductions for companies that engage in flood mitigation activities.

Forest fire resilience in Chamusca, Portugal:
The Portuguese case study in Chamusca will provide an analysis of the events of 2003, revisiting major drivers leading to catastrophic fires in Chamusca, and an assessment of the measures and policies to mitigate of impacts and risks of forest fires. Hereby the state incentivized forest owners to extract the burned cork from the trees after the 2003 wildfires through grants.

Health preparedness and heat wave response plans, trans-European:
The objectives of this case study are to examine health sector plans that address preparedness and response to heat-waves, and to reach a consensus on the prioritisation of health interventions for heat-waves. Subsidies in form of grants can potentially facilitate adaptation retrofitting of buildings, particularly where vulnerable people are likely to reside.

Testing the Solidarity Fund for Romania and Eastern Europe:
An important instrument in Europe for providing additional capacity to governments following major disasters is the European Union Solidarity Fund. However the European Commission recognised the dangers of moral hazard if governments take on fewer preventive measures because they can rely on post-disaster support from the EU. Considering the introduction of pre-disaster risk management in the EUSF scheme also includes the assessment of suitable economic instruments. Thus subsidies or tax reductions for certain insurances might play an important role for providing alternatives to post-disaster payments.

Conclusions
Subsidies can appear in different forms, and are frequently employed instruments in policy generally. Our assessment has identified the following opportunities and challenges regarding the potential of subsidies to promote risk management.

Opportunities comprise
- DRM can be promoted via subsidies for recovery.
- Subsidies have the potential to trigger important indirect risk management investments that would not happen otherwise.
- Insurances that would otherwise not affordable can be subsidized thus promoting systemic risk management.

Challenges amount to
- Danger of moral hazard is given for all three levels of risk management subsidies.
- Danger of maladaptation and misallocation of resources in case of inappropriate characteristics and level of subsidies.

Regarding the attractiveness of subsidies for stakeholders in the context of a MSP, subsidies are a preferred option for the private sector including households. Given that the public sector usually finances subsidies its focus should be on public goods as otherwise such reallocation of tax money might not be acceptable under equity criteria.

In terms of suitable subsidy instruments, particularly direct payments (grants) and tax reductions seem to be appropriate in the context of proactive risk management and adaptation. The IPCC's 5th assessment report also considers subsidies, besides taxes, as generally preferable instruments regarding efficiency (see Chambwera et al., 2014). Several existing examples have been identified and four Enhance case studies have applied or intend to apply subsidies as an economic instrument. Thus we recommend further exploring the suitability of grants and tax reductions in the context of multi-stakeholder partnerships. The drawbacks of publically financed private goods and moral hazards at all levels of risk management jeopardizing equity criteria will be particularly analyzed.

4.2 Taxes and fees

Presentation of the economic instrument

Taxes are financial transfers by economic actors to the state without any direct service in return. "General taxes are levied on a broad section of the public, such as wage earners or property owners. Selective sales taxes are levied on the sale of particular products and services. Fees or levies are charges for special municipal services, sometimes imposed only on the subset of the population benefiting from the service" (ICLEI, 2010).

The main purpose of taxes is to create government revenues that are financing public expenditures. These public expenditures might also be a part of a public adaptation policy. This is clearly the case if these measures are public goods such as sea and river dikes.

There are some markets where private behaviour does not lead to an optimal outcome. This is normally due to differences between the individual cost of consumption and the social cost. In this case taxes can be used to direct private behaviour towards a socially optimal behaviour. Then taxation has a double dividend: it improves market behaviour and leads to government revenue at the same time (see Bräuninger et al. 2011).

One of the typical taxes or levies in the context of risk management are taxes on land and buildings. Usually they are linked to a service from the collecting (public) institution in return (Bräuninger et al., 2011). For example residents living in coastal areas prone to flood risks have been responsible for construction and maintenance of dykes in Northern Germany since the 15th century. Today local population is not involved in direct construction or maintenance activities but often contributes to its funding by levies on private property protected through dykes (see Mitchell and Myers, 2013). Besides these "land levies" other instruments such as carbon or energy taxes would have a relation to climate driven disasters in a broader sense.

Typically taxes and fees are levied on carbon, energy and land use. Taxes and fees on carbon and energy have been widely applied, yet land use taxes – which are the ones immediately relevant to disaster risk management – are used sparingly. This may be due to the fact that their applicability is limited to landscapes such as agriculture and forest, and natural capital (biodiversity, ecosystems and water) (Bräuninger et al., 2011). However, since all countries in the European Union have a land or property tax system, these instruments remain an important site for investigation.

The link of taxes and fees to risk management

In the following section we analyse whether taxes and fees can contribute to risk management and risk reduction. It is distinguished between the three levels of risk reduction as described above.

Direct risk reduction

Collected taxes or levies can be used for emergency response, compensation or reconstruction activities ex-post the natural disaster. These fall into two broad categories:

1. Land taxes applied to properties in a high-risk area to cover disaster risk management costs incurred by the local government. These taxes are based on the principle that property owners choosing to reside or conduct business in a high-risk area should be responsible for paying for the services of risk reduction, preparedness, emergency response and recovery incurred by the local government (Deyle and Smith, 2000).

2. Catastrophe taxes, applied to the general population - for example within the income tax system - to spread and cover costs incurred by government in response to a major disaster (Kunreuther and Linnerooth-Bayer, 1999)

Type 1 – land taxes in high risk areas, are frequently evoked as a potential instrument for raising revenue for disaster risk management, yet application remains scarce. This is possibly due to the difficulty in estimating the risk and associated costs, and political unattractiveness. Type 2 – catastrophe taxes, are seen as relatively more applicable, yet still politically difficult. This concept has been applied in Australia, when the Government introduced a temporary flood reconstruction levy following a major flooding event (see experience and evidence below). More commonly, the tax system is utilized in recovery to provide disaster victims with tax relief, see subsidies section above for discussion.

Indirect risk reduction through incentives for adaptation and increased resilience

Taxes or fees could be used for incentivizing population to move to resilient less risky living areas. Thus, constructions in areas with lower disaster risk levels would be imposed lower taxes. If the tax rate is set appropriately, only high value added activities would remain in the vulnerable area, reflecting individual optimization (Bräuninger et al., 2011) Higher tax revenues from areas with higher disaster likelihood could be used for financing risk reduction activities such as ecosystem restoration and the raising of dyke levels. The IPCC's Special Report on Disaster Management states that "land use planning alone, may not be successful as a singular strategy but when coupled with related policies such as tax incentives or disincentives [...] it could be effective (IPCC, 2012: 306). Bräuninger et al. (2011), among others, identify land use taxes as some of the most promising instruments available for adaptation, particularly in relation to dis-incentivizing development in high risk areas and soil sealing which leads to increased flood risk. A land tax could be applied to an area which is forecast to become increasingly vulnerable to disaster but where this risk is not being accounted for within the current market. Similar to their application to finance direct risk, application is scarce as they are rarely perceived as fair (Sterner, 2003).

Land taxes are not the only measure within this category available and in use for reducing risk and/or avoiding risk creation. The use of taxes and fees to protect biodiversity is important because of the role natural systems have in reducing risk, particularly in regards to flood. It may be argued that hunting and fishing fees can restrict habitat exploitation to a sustainable level. This is discussed further in section 4.4.1 on Payments to Ecosystem Services.

Managing systemic risk

Taxes and fees can form part of a comprehensive approach to risk management and may include provisions which incentivize uptake of insurance. Typically these schemes are set up as tax deductions for costs incurred in the purchase and/or utilization of insurance productions, these are discussed in the subsidies section above.

Experience and evidence

Taxes in the risk management context

Levies and fees with regard to risk management:

- Local flood defence levy, UK:_The funding will be allocated to Lead Local Flood Authorities (LLFAs). LLFA's are established under the Flood and Water Management Act 2010. The levy finances grants to help councils to protect and support their own communities when managing flood risk. The funds have been/will be allocated based on the individual risk that each local authority has. Each local authority decides where the money will be of most use.[6]
- Temporary Flood Reconstruction Levy, Australia: A levy, at a rate of 0.5% on annual income exceeding A$50,000 (approx. €40,000) and 1% on income over A$100,000 has been introduced to fund a multi-billion-dollar rebuilding program after floods devastated infrastructure and ruined thousands of homes and businesses on the eastern coast in January 2011. Flood-stricken households are exempt.[7]

Application in the context of ENHANCE case studies

Based on the feedback gathered in our questionnaire on economic instruments we are able to identify applied taxes and fees in the context of the Enhance case studies. The following list outlines current examples:

Climate variability & technological risk in the Po basin, Italy

This case study will explore extreme weather and climate events (intense and deficient precipitation) along with ripple effects including key lifeline interruptions, industrial accidents, water crisis, and pollution. It will include proposals for improvements in emergency management, and possible insurance systems (see Surminski and Mysiak, 2013). Hereby mandatory land use charges in connection with flood protection service could play a key role.

[6] See http://www.legislation.gov.uk/ukpga/1995/25/contents
[7] http://www.austlii.edu.au/au/legis/cth/bill_em/tlafrlb2011613/memo_0.html

Flood risk management for critical infrastructure in the Port of Rotterdam, Netherlands
It will be explored whether the Government could provide higher safety standards against fees.

Forest fire resilience in Chamusca, Portugal
A fuel tax might be applied in order to fund permanent forestry forest fire protection activities.

Drought management in Jucar river basin district, Spain
This case study explores the usefulness of economic instruments that so far have not been applied in the Jucar Basin District, private-public partnerships, and regulatory instruments to improve the resilience to droughts of water resources systems. It will be explored whether water tariffs, taxes or charges could enhance the quality and availability water resources.

Conclusions
Taxes, levies or fees are important instruments for creating state revenues and financing government spending all over the world. Thus they are a precondition for disaster risk reduction and risk management financed by the state and furthermore allow to indirectly incentivizing behaviour of population prone to potential disasters. Our assessment has identified the following opportunities and challenges regarding the potential to promote risk management.

Opportunities comprise

- For direct risk management taxes can be applied to finance recovery. Here we see a strong overlap with subsidies.
- Taxes can be applied as a kind of “polluter pays principle” financing indirect risk management activities that benefit the tax payers. Further they dis-incentivize certain locations motivating resettlement.

Challenges amount to

- Political unattractiveness for implementing taxes on all three dimensions.
- Danger of allocation of taxes as a public good to finance specific private goods.

Regarding the attractiveness of taxes for stakeholders in the context of a MSP, they are usually not a preferred option for the private sector including households as they directly reduce the income level. From the point of view of the public sector, taxes can fulfil high equity standards when they are applied according to the “polluter’s pays principle”. However policy makers often refrain from introducing new tax approaches as they are considered as politically unattractive.

Due to their interesting potentials of addressing several dimensions of risk management while taking into account equity principles we recommend further exploring the suitability of taxes and fees in the context of multi-sector partnerships. A particular focus will be on land taxation.

4.3 Licences, permits and advanced market commitments

Presentation of the economic instrument

Markets, based on tradable units, are less commonly utilized for promoting risk reduction and adaptation. Since the 1990s, they have been increasingly applied in the environmental sector, particularly for internalising external costs of air pollutants. Most environmental markets are creating demand through regulated rights to use environmental goods. Typical examples are the trading of emission rights for SO_2 and NO_x in the United States since the early 1990s or the European CO_2 Emission Trading System since 2008 (see also Burtraw and Szambelan, 2009). In a capped system the scarcity of units generates demand whereas open systems allow generation of offset units by reducing e.g. emissions below a baseline (see also Bräuninger et al., 2011). Such markets have also been discussed generally in the context of promoting risk reduction or adaptation activities (e.g. see Butzengeiger-Geyer et al., 2011), however they cannot be used in practice as adaptation is a private good, for which there is a market already (such as using insurance instruments). Thus there is no rationale for policy intervention.

The link of licenses, permits and advanced market commitments to risk management

In the following section we analyse whether licenses, permits and variations can contribute to risk management and risk reduction. We distinguish between the three levels of risk reduction as described above.

Direct risk reduction

We cannot identify any link between a market system based on licenses, permits or advanced market commitments and direct risk reduction through e.g. compensation payments.

Indirect risk reduction

A functional market with sufficient demand could theoretically trigger supply through risk reduction and adaptation activities. However as this instrument is discussed on a purely theoretical level, there is no evidence about effectiveness of such as scheme.

Managing systemic risk

In theory, there would be a link as risk is being traded; in practice, due to a lack of implementability, this link does not exist.

Experience and evidence

In practice, no system of licenses, permits or advanced market commitments has been introduced for risk reduction or adaptation.

Application in the context of Enhance case studies

Based on the feedback gathered in our questionnaire on economic instruments, we are able to identify advanced market commitments in the context of one ENHANCE case studies as follows:

> *Forest fire resilience in Chamusca, Portugal*
>
> It is envisaged that the government pays a premium for burned pine wood until 3 months after the fire. During that time the quality and therefore economic value of the wood has significantly decreased. This advanced market commitment would be similar to a compensation subsidy for wood industry, forestry companies and forestry associations.

Conclusions
Licenses, permits and advanced market commitments are common economic policy instruments, but not yet used for risk management or adaptation purposes. Only one case study considers advanced market commitments, which are similar to subsidies, we come to the conclusion that this EI is currently very limited in terms of applicability, yet, we will monitor it further in the Chamusca case study in terms of challenges and opportunities.

Opportunities comprise
- Licenses, permits and advanced market commitments have been used as policy instruments for other problems, such as climate change mitigation

Challenges amount to
- Licenses, permits and advanced market commitments have not been used in DRM a lot
- Adaptation is a private good, whereas licences and permits aim at trading formerly public goods

4.4 Other Market Based Instruments

This EI category takes into account Payments for Ecosystem Services, water markets and water pricing.

4.4.1 Payments for Ecosystem Services

Presentation of the economic instrument
Payments for Ecosystem Services (PES) pay land owners or users to preserve the environmental health of the ecosystem. These payments are made because the ecosystem provides public and environmental health services which the society would like to maintain, but preserving them has a private cost to the land holder (Chambwera et al., 2014). In regards to risk management, healthy and thriving ecosystems provide important services, for example: upstream vegetation reduces downstream flood volume; coastal mangroves protect against storm surge; hillside vegetation helps prevent landslides; green infrastructure on roofs in cities reduces flooding and the urban heat island effect (UNISDR, 2011).

There are three main types of PES schemes (UNECE, 2007):
1. Public schemes where a government is the main 'purchaser' of the ecosystem service, typically via a land use or management practice adopted by the land user.
2. Private schemes which are often local in scale and self-organized, where non-government actors such as firms, NGOs, farmers' associations or cooperatives, or private individuals purchase the ecosystem service.
3. Trading schemes where markets are established to buy/sell/lease permits or quotas.

UNECE (2007, p. 10) identifies six most common financial arrangements for the exchange of payments for ecosystem services: "(for sellers) direct compensation, investment or development funds, and land purchasing and (for buyers) customer-charged payments, lump-sum contributions and tax-based contributions".

Direct risk reduction
We do not find a link.

Indirect risk reduction
Payments for Ecosystem Services can act as an indirect risk reduction incentive if they are applied to disaster provisioning services. For example, payments for flood protection by maintaining or restoring upstream forest ecosystems are a potential PES scheme which would reduce flood risk *ex-ante* (see Rusenski Lom, Bulgaria example below).

Managing systemic risk
We do not identify a link.

Experience and evidence
UNECE's (2007) review of payments for environmental services in Europe does not identify any schemes relating specifically to disaster risk management. They identify several successful schemes which provide payments for the provision of clean water for drinking free from pesticides. The success of these schemes has led to the exploration of expansion of European PES schemes to consider flood protection services. In Rusenski Lom Nature Park, Bulgaria, there is a pilot PES scheme led by the World Wildlife Fund (WWF) underway which includes valuations for flood protection (FAO 2013).

Application in the context of ENHANCE case studies

Forest fire resilience in Chamusca, Portugal
After the big fires from 2003 and 2004 in the southern part of Portugal emerged a partnership between WWF and Coca-Cola to recover the local biodiversity on the natural park of Guadiana. A similar approach might also be applicable for the Chamusca case study region.

Conclusions
Cost-benefit analyses have shown that ensuring the health of ecosystem provide huge value for money for reducing risk. However ecosystem services remain difficult to value and this is identified as a main obstacle to the uptake of schemes which provide payments for ecosystem services (UNISDR, 2011). The limited scope of application is reducing effectiveness and transaction costs are potentially significant (Bräuninger et al., 2011). Despite this, the IPCC (Chambwera *et al.*, 2014) identifies payments for ecosystem service schemes are a mechanism with much potential for incentivizing adaptation as experience and guidance on implementation grows. We will continue to marginally monitor the applicability for DRM of Payments for Ecosystem Services and identify key opportunities and challenges regarding the potential to promote risk management.

Opportunities comprise
- Linking up to ecosystem valuation and payments can provide massive co-benefits, and thus send strong signals for risk reduction

Challenges amount to
- Valuing ecosystem services
- No experience with reference to disaster risk management

4.4.2 Water markets

Presentation of the economic instrument

Since prices in water do not reflect the economic value of water in its uses, allocation of scarce water across sectors is likely inefficient. In theory, the development of voluntary, mutually beneficial trades (water markets) can help to address inefficiencies in the current allocation of supplies by moving water to its highest-valued uses, providing an incentive for more efficient water use. The potential benefits from water trading have been discussed by economists for many decades (e.g. Mass and Anderson, 1978; Howe, 1986; Saliba and Bush, 1987). Water markets can refer to the permanent exchange of water-use rights (water sales) or the short-term temporary exchange of a given quantity of water between users (or spot water markets). The majority of permanent transfers involve the purchase of agricultural water rights by the urban sector. In the case of option water markets, water transfers are contingent to certain drought conditions (water shortages) set in the contract. Water banking occurs when an intermediary (often a public organization, such as a river basin agency or a state agency) leases water from some users to lease it to other users. The selling prices include the administrative and technical costs of the bank. Finally, water markets can be either formal (with formal contracts within the legal framework, in some cases requiring public approval of the water transfer in order to avoid potential environmental and third party impacts) or informal markets (e.g. informal markets of groundwater among farmers in India and Pakistan). Water markets often requires government intervention to create the necessary conditions for markets to operate, including the definition of the original water rights allocation, the creation of the institutional and legal frameworks for trading, and the investments in the basic infrastructure to allow water transfers (Lund and Israel, 1995; Dinar et al., 1997).

The link of water markets to risk management

Direct risk reduction

We did not find a link to direct risk reduction.

Indirect risk reduction

Water markets (WM) provide a flexible water allocation mechanism that allows to increase the economic efficiency in water allocation by securing water supply for high-value uses without the need to develop new costly water resources. WM contribute to reduce water supply risks and uncertainty, increasing water availability and reliability of supply under current and future conditions (Pulido-Velazquez et al., 2004), including adaptation to climate change (Loch et al., 2013). The additional flexibility provided by WM provides also a valuable tool for managing seasonal droughts (Charaklis et al., 1999).

Water users are empowered by requiring their consent to water reallocations and compensation for any water transferred. WM provide security of water rights tenure if water rights are well-defined, so that water users can invest in water-saving technology knowing that they will benefit from the investment. WM also disseminates information about the real value of water, and induce water users to consider the opportunity cost of water, providing incentives to efficiently use water and to gain additional income through the sale of saved water. A market system would also provide incentives for water users to take into account

the external costs imposed of water use. While volumetric water pricing for irrigation would be seen by farmers as an expropriation of their traditional water rights, imposing income losses, the market-based approach is more acceptable to them (Dinar et al., 1997).

But WM can also increase pressure on water resources, and mobilize unused rights. WM are prone to market failures, especially because of the presence of externalities, natural monopolies, and public goods competing with private demands. A system of tradable water rights can result in inefficient allocations due to different reasons like: poorly defined water rights, thinness of the market, market power and speculative behavior, uncertainty on water availability, the transaction costs and the external effects. All these aspects are affected by the type of water market, water rights and regulatory framework. WM can be subject to important transactions costs, which include the cost of the necessary infrastructure (for conveying, storing and perhaps treating the transferred water), the cost of identifying interested buyers and sellers, and the legal costs of creating and enforcing contracts and obtaining regulatory permission. Transaction costs can have a significant effect on the final price, with important implications in the character and number of the resulting water transfers (Carey et al., 2002). Finally, effective market allocation requires that third-party effects of water trading are identified and accurately quantified, and the associated costs are fully taken into account in the exchange process. Market failures can be corrected, or at least reduced, by introducing appropriate water right and incentives structures (Griffin and Hsu, 1993; Spulber and Sabbaghi, 1994).

Managing systemic risk
There is no link to systemic risk management

Experience and evidence
Informal water markets are common (e.g. active groundwater markets in India and Pakistan; Diwakara, 2005, also in Mexico) and have been applied for decades (e.g. in Southeastern Spain; Mass and Anderson, 1978). However, despite the potential gains from trading, formal intersectoral water markets have been more slowly developed. The most important active formal water markets are in Australia, Chile, US (e.g. California, Colorado, Arizona, Texas), and South Africa, with significant differences regarding institutional configuration, regulatory framework and market properties (Bjornlund and McKay, 2002; Grafton et al., 2010).

Application in the context of ENHANCE case studies

Water markets in the Jucar river basin
In ENHANCE, a hydroeconomic modelling approach (Pulido-Velazquez et al., 2008; Harou et al., 2009) will be applied to the analyse of the potential contribution of water markets to drought risk management in the Jucar case study (Spain).

Conclusions
Ideally water markets enhance economic efficiency by encouraging resources to move from lower to higher-valued uses. The introduction of water markets and water banks makes possible to balance supply and demand and to lessen the effects of severe droughts, reducing water supply risks and uncertainty. But water markets are also prone to market

failures, and government intervention and a proper regulatory framework (for determining prices, rules and liability) are needed in order to avoid undesirable outcomes.

Our assessment has identified the following opportunities and challenges regarding the potential to promote risk management.

Opportunities comprise

- Water markets are in use and good evidence.
- Water markets provide a flexible water allocation mechanism that allows to increase the economic efficiency and thus link to risk reduction (i.e. manage water supply in the face of droughts).

Challenges amount to

- Prone to market failures.
- Large potential for increased inequities.

4.4.3 Water pricing

Presentation of the economic instrument

Better pricing is probably the most underutilized of all the tools available for solving water scarcity problems relative to its potential (Griffin 2006). Existing water prices typically are not related to the real water economic value and do not reflect resource scarcity. Water is often underpriced, and as a consequence, the quantity demanded frequently exceeds the supply, leading to a nonsustainable use of the resources. A proper water pricing policy has the potential to promote improved economic efficiency (Pulido-Velazquez et al., 2013).

The real cost of water use has two elements: the cost of its provision and its opportunity cost. The key challenge for economic efficiency is to ensure that opportunity costs are considered in resource allocation decisions. By ignoring this resource opportunity cost, water is undervalued, what can lead to significant errors in investments and water allocation among users. Users should get a signal of water's opportunity costs so that they behave accordingly. When the price of water reflects its marginal cost (marginal cost pricing), the resource will be put to its highest-valued uses and theoretically an optimal resource allocation would be reached, for which the marginal productivity of water would be equal across the different uses and over time and society's economic welfare would be maximized.

Despite the apparent simplicity of the concept, measuring the opportunity costs of scarce water is difficult. Since water markets are usually absent or inefficient, scarcity values frequently go unrecognized, and the assessment of these opportunity costs requires a systems approach and a proper method to estimate the value of water for the different users in the system to develop shadow prices reflecting the value of water (Pulido-Velazquez et al. 2008).

<u>Direct risk reduction</u>

Water pricing has an essential role in water management: a financial role (for cost recovery of investments, but also the possibility of using the additional funding from pricing to further secure future water supply).

Indirect risk reduction

Water pricing acts as an economic instrument for incentivizing a more efficient water use. While water pricing is ubiquitious, the use of water pricing as an economic instrument has only been explored rarely for disaster risk management and climate adaptation, thus we have not identified experience and evidence or the application in an ENHANCE case study.

Managing systemic risk

There is no link to systemic risk management.

Application in the context of ENHANCE case studies

Water pricing in the Jucar river basin

The Jucar case study (Spain) will also study waterpricing as an instrument.

Opportunities comprise

- Water pricing with good evidence – apart from DRM.
- Water pricing has an essential role in water management

Challenges amount to

- Pricing issues as measuring the opportunity costs of scarce water is difficult.

4.5 Risk financing instruments

There are many instruments for dealing with the financial burden imposed by disasters. At the most general level, we distinguish *risk financing* from *loss financing* instruments. The important distinction is that risk financing is purchased/organized by persons or a community at risk purposefully and in anticipation of risk, whereas loss financing is arranged by people, governments and the state, often ad hoc, after an event. Risk transfer through key tools such as insurance shares risks before a catastrophe occurs and requires the use of predisaster (ex ante) arrangements in which the risk cedent incurs a cost in return for the right to receive a potentially much larger amount of money after a disaster occurs.

Insurance and other RFI do not automatically and explicitly lead to physical risk reduction, meaning that the risk is mainly redistributed instead of being reduced. But, if these instruments are well designed then they can promote the reduction of risks, aid in the recovery process by compensating losses that may be too large for households and businesses to bear individually thus reducing indirect disaster losses, as well as to create an environment for exploiting opportunities. In the following, we will not further discuss loss financing instruments in isolation, as they are reactive and thus do not help to incentivize or share risks in a planned and systematic manner. However, we will discuss some of those in combination with RFI. In the remainder and in general , we distinguish private sector insurance, property insurance (including household contents), agricultural insurance for crops and business insurance, and sovereign insurance incl. intergovernmental risk pooling

Presentation of the economic instrument

Insurance risk transfer has been used for centuries as a tool to manage the risk of uncertain losses (Freeman and Kunreuther, 2003). In simplified terms, insurance acts as a mechanism to transfer risks or part of a risk from the insured to the insurer, with a return to the insurer

in the form of a premium payment. This transaction reduces the uncertainty associated with risk and is a vital mechanism that drives economic systems. Without insurance, those activities and processes that would often be labelled as too risky would not be commenced and those affected by a loss may experience difficulty in recovery (Surminski and Oramas-Dorta, 2013). The insurance company can play this risk spreading role because risk averse insured are typically willing to pay insurance premiums that are higher than the expected value of the covered loss (the risk) (Botzen and van den Bergh, 2009).

The main role of insurance is the transfer of risks and the provision of compensation in the event of a loss. As an economic tool it can take many various forms: It may be provided by public or private entities or by both cooperating in a public-private partnership, be compulsory or voluntary, cover a range of different insureds and hazards, and the cover provided may be loss based (a loss must be evident) or parametric (triggered by a certain event). Exploring this in more detail the range of those who can be insured varies in both size and type, with individuals, businesses, insurers/reinsurers (via reinsurance), organisations or governments all holding cover. Also the type of hazard and exposure that insurance can cover may vary, for example, floods and illness (hazard), to homes, motor cars or business interruption (exposure) each maintaining varying levels of coverage design (such as deductibles, exclusions and conditions).

Within many developed countries insurance is common and widely used tool, although availability, demand and scope vary significantly from country to country owing to local customs and traditions, different levels of risk and risk attitudes and regulation of insurance markets (e.g. Schwarze and Wagner, 2007; Paudel et al., 2012). Poor households in transition and developing countries commonly lack access to insurance markets so that most damage caused by natural hazards is not carried by the insurance sector (Hoff et al. 2005). A key factor is affordability. In addition, limited availability of loss data, a lack of an insurance culture, and poor contract enforcement are other factors that impede the development of natural disaster insurance. Nevertheless, innovative insurance schemes such as micro insurance and index based insurance could expand insurance coverage against natural disasters,

Direct risk reduction

The main function of insurance is to reduce risks in terms of alleviating the financial risks associated with disaster losses: claim payments received quickly and sufficiently post-event will reduce the overall burden from a disaster. There is ample evidence that this is the case and works fine (see Chambwera et al., 2014).

Indirect risk reduction

Insurance can act as a tool towards averting risk, with the insurance industry being exemplified as a ‘bridge between public and private sectors in addressing risk awareness, physical resilience and financial preparedness’ (WEF, 2011). The theoretical potential for insurance to reduce risk is well versed in literature and there are several ways in which it may be considered for such a role. Crichton (2008), for example, suggests how insurance may lead to physical risk reduction specifically for flooding with several key areas acknowledged as leading to risk reduction; identifying areas at risk, catastrophe modelling, economic incentives to prevent development in the floodplain, data on the cost of flood schemes for flood risk management appraisal, resilient reinstatement after a flood event and support for temporary defence solutions (Crichton, 2008). Paudel et al. (2012) continue this with a clear distinction between ‘risk assessment and mapping’, ‘policies and regulations

integrated into the insurance system' and '(financial) incentives that insurance provides to policyholders to invest in mitigation' (Paudel et al., 2012).

Because insurance instruments (and other RFIs) require detailed analysis of risks, they can both raise awareness and provide valuable information necessary for responding to and reducing risk. In some countries, insurers with other partners have made flood and other hazard maps publicly available. Insurers can inform their clients directly about the levels of risks they are facing. Insurers can also present their clients with information on the available risk prevention measures. By pricing risk, insurance can provide incentives for its reduction. If natural disaster risks are factored into the premium calculation, it should theoretically provide incentives for the clients to reduce these risks. For this to be effective, the pricing has to reflect changes in the risk levels when risk prevention measures have been implemented. For example, policyholders who invest in measures that limit natural disaster damage (e.g. by flood proofing homes) should be rewarded by insurance premium discounts (Kunreuther, 1996).

Insurers and other providers can require risk reduction as a contractual condition. For example, insurers have required commercial goods to be stored at a specified height to avoid water damage as a condition for insuring a business.

Insurance could provide a broader insurance coverage if natural disaster risk are reduced. For example, in France deductibles can be increased for policyholders who live in communities that face repeated flooding and do not have adequate risk mitigation plans which include damage mitigation measures in place, while deductibles are lowered if such plans and risk reducing measures are taken (Poussin et al., 2013).

Providers of insurance can serve as lobbyists or partners with government and communities to promote land use planning, emergency response and other types of risk-reducing behaviour. In many countries, for example, insurers have co-financed research institutes and disaster management centres, and in other cases, have partnered with government to achieve changes in the planning system and more investment in public protection measures.

On the other hand, insurance can lead to moral hazard, which describes the disincentive for risk prevention provided by the perception of financial security when purchasing insurance cover. This is more the rule rather than the exception (see Chambwera et al., 2014) and will be discussed further below.

Managing systemic risk

Insurance (and other RFIs) allow households and businesses to plan with more certainty, and by providing a safety net they facilitate cost-effective, yet risky, investments. Index-based or parametric insurance, where products are written against physical or economic triggers against events that cause loss, not against the loss itself, hold high appeal (traditional insurance is indemnity based, where products are written against actual losses). While little implementation and analysis has been done in Europe, this new generation of insurance products is being offered in developing countries based on parametric mechanisms

A recent example in Malawi shows that insurance can also have benefits even in the absence of a disaster. Because of drought risk, groundnut farmers in this country have historically experienced extreme difficulty in receiving loans that enable them to purchase more productive seed and other agricultural inputs. A pilot program initiated in 2005 provided the safety net necessary for farmers to plant higher-risk seeds that increased their productivity

(in this case) five-fold (Hess and Syroka 2005). Overall, for the context of developing countries, analysis conducted by Surminski and Oramas-Dorta (2013) identifies that different levels of direct links between risk transfer and risk reduction exist:

- risk awareness-raising initiatives, such as the provision of risk-relevant information and knowledge transfer to educate policy-holders and the public about preventive measures;
- capacity-building through knowledge transfer and educational elements;
- explicit incentive structures for risk reduction, such as risk based pricing, where premiums reflect risk such as charging according to local flood risk levels;
- compulsory risk reduction, such as requiring policy holders to take certain preventive measures as a condition for cover.

The IPCC's report on managing the risk of extreme events (IPCC, 2012) also supports the overall idea that 'risk sharing (formal insurance, micro-insurance, crop insurance) can be a tool for risk reduction and recovering livelihoods' in the case of extreme weather events, yet also states that disincentives exist, particularly if the scheme is not correctly structured.

What is the potential of insurance to lead to improved risk management? There are many risk management options in different sectors that the different private and public insurance arrangements may incentivize (see also table below for key options), such as (see table 3).

- Flood proofing of buildings and property,
- Retrofitting of houses (e.g. against windstorm),
- Local flood protection measures,
- Flood proofing infrastructure,
- Building larger scale flood protection schemes,
- Switching to more heat and drought resistance cultivars,
- Implementation of more efficient irrigation measures.

Table 3: Insurance and adaptation according to key sectors

Policy sector as per White Paper	Sectoral uptake	Type of insurance	Incentivized private adaptation
Private property	+++	Property insurance: private properties are insured against flood and windstorm risks	Risk (flood and windstorm)- based pricing and deductibles can incentivize the following efforts Flood proofing of buildings and property (raising plinth, adapting cellars etc.) Retrofitting of houses (e.g. against windstorm)
Production Systems and services	+++	Property business insurance: Insurance and other RFI are well used by industry to cope with the financial consequences of disasters, e.g. against flood and windstorm risks. Larger businesses often self-insure by pooling risks across their different operations in different locations or countries	Risk (flood and windstorm)- based pricing and deductibles can incentivize the following efforts Flood proofing of buildings and property Retrofitting of houses (e.g. against windstorm) Resilience of supply chains, factories and their inventory etc. Local flood protection measures with private good characteristic

Physical infrastructure (private and public)	++	Sovereign insurance and regional pools for flood and windstorm risk Insurance can be used for infrastructure, but in many developed countries the public sector self-insures via its taxing function	Sovereign insurance contracts via risk based pricing and deductibles can incentivize • Flood- proofing infrastructure • Retrofitting buildings • Building larger scale flood protection schemes
Health and social policies	-	Less relevant. However some risks such as heat stress and disease may be covered by life, health or employers' insurance, which are very different from catastrophe insurance	-
Agriculture & forests	+++	Agricultural insurance for drought and heatwave risks. Very relevant for crop insurance, less so for forestry, as most forests are self-insured, often implicitly	Risk (drought and heatwave)- based pricing and deductibles can incentivize the following efforts • Switching to more heat and drought resistance cultivars • Developing crop variants with longer growing cycles • Implementation of (additional) irrigation measures
Biodiversity, ecosystems, water	-	These "non-tangibles" are less insurable, so applicability is very limited	-
Coastal and maritime areas	+++	Property insurance: private and business. Generally RFI can be and are used, if the underlying hazard is extreme such as storm surge, but less so for 'inevitable' risks such as sea level rise and coastal erosion. Physical assets located at sea can be handled by RFI's.	• Flood proofing of buildings and property • Retrofitting of houses (e.g. against windstorm) • Local flood protection measures

Source: Bräuninger et al., 2011

Experience and evidence

In theory, the potential of insurance to work in favour of risk reduction is agreed amongst most observers. However, the evidence of the implementation and effectiveness of such measures is extremely limited. Academic debate has focused primarily on developed countries and property insurance, mostly in the context of flood (Michel- Kerjan and Kunreuther, 2011; Crichton, 2008, Surminski et.al. 2013).

In the UK, a recent proposal for a new flood insurance scheme (Flood Re) has been released, principally due to rising risk levels and despite existing reduction efforts (ABI, 2013). The current scheme in place, the Statement of Principles (SoP), specifically addresses several key aspects that can lead to risk reduction; a need for better flood risk information, stricter planning policy and more investment in flood defences. Compounded by the need for affordability and availability of flood insurance to households the proposed new scheme, Flood Re, creates a pool for high risk properties, funded by all policy holders. It is seen as a transition towards risk reflecting pricing in the future, but so far the proposals do not contain any elements of incentivizing risk reduction (Surminski et.al 2013).

In Austria, the 'Hora' risk mapping initiated and driven by insurers for public awareness should in theory lead to risk reduction by policyholders but the resulting physical risk reduction efforts are scarce (Surminski, 2010). As these examples show, measuring success, implementation and effectiveness of these remains a challenge and there appear to be a

number of barriers and trade-offs limiting the potential of insurance to act for risk reduction. Bräuninger et al. (2011) discuss the barriers for incentivising risk reduction for three main insurance based approaches; risk pricing, reducing vulnerability and provision of risk information;

Picard (2008) highlights the trade-off between the effectiveness of risk based pricing and equity – as those most vulnerable could possibly not be able to pay for risk-based premiums. Other studies have explored the link between premium pricing and risk reduction through methods such as interviews with the insured, hypothetical modeling and willingness to pay exercises. In Germany, Thieken et al. (2006) found that insured householders are more likely to undertake risk reduction measures over that of the uninsured- implying that flood insurance sets a precedent for action from policyholders. In the Netherlands, evidence presented by Botzen et al. (2009) suggests that homeowners would be prepared to invest in flood risk reduction measures if this led to an insurance premium reduction. In fact two-thirds were found to be willing to invest in water barriers, a quarter to move central heating apparatus to a safer location and a fifth to instate water resistant flooring.

Although we know little about how this risk reduction may actually contribute to risk reduction in established insurance markets, we know even less in about it in the context of developing markets as again evidence remains extremely limited. The suitability of insurance related instruments for disaster risk reduction in vulnerable countries was investigated by Suarez and Linnerooth-Bayer (2011). The study concludes that these tools can effectively spread losses both spatially and temporally but also to other parties, resulting in a reduced vulnerability and enhancing preparedness. However several obstacles are also present requiring support from international development communities- this is important if such programs are to progress. The potential links between risk financing (including insurance) and risk reduction are also summarised with a wide range of studies presented that exemplify where insurance can influence behavior and physical risk reduction. This can be in a moral hazard context (insurance leads to risky behavior), where insurance prompts risk reduction measures or through preventative measures and improved building standards (Suarez and Linnerooth-Bayer, 2011).

Application in the context of ENHANCE case studies

In ENHANCE, several case studies explore the current provision of natural disaster insurance and the role that public and private partnerships play in transferring climate risks:

- *Multi-hazard risk assessment in Po river basin basins (Italy)*
- *Flood risk and climate change implications for Multi Sector Partnerships (United Kingdom)*
- *Insurance and forest fire resilience in Chamusca (Portugal)*
- *Flood risk management for Critical infrastructure (The Netherlands)*
- *Testing the Solidarity Fund for Romania and Eastern Europe*

Conclusions

In summary, we note a gap of exploring how risk reduction and risk transfer can work hand-in hand – this applies to developed markets and to those where there is little history of insurance. The key message that emerges from this dialogue is that the design, form and implementation of a risk transfer scheme will determine the promotion and effectiveness of risk reduction and the level of moral hazard.

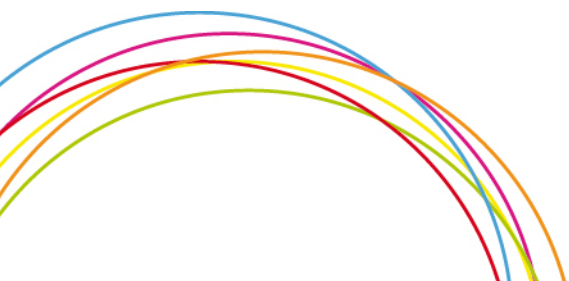
Key opportunities and challenges are:

Opportunities

- Insurance reduces the cost of risk bearing, and is attractive to insured and insurers.
- Insurance in theory promotes risk reduction, thus is attractive to insured and insurers alike.
- Insurance can help to manage systemic risks, so link up with socio-economic 31development.

Challenges

- Insurance payouts have been useful, yet, often purely private-based insurance would be expensive, and generally there is need for direct or cross-subsidization.
- Insurance has often provided for moral hazard, and the link to indirect risk reduction is weak.
- The systemic function is bets provided for index-based insurance, which has not really been applied in Europe so far.



5 Overall findings and conclusions

Table 4 summarizes part of our review in terms of the theoretical link of EI to risk management, the identified evidence as well as the anticipated assessment and consideration in the case studies. We identified that all three dimensions of risk reduction are covered by some of the instruments and case studies. Indirect risk reduction is predominantly used and there is wide experience and evidence of suitable instruments. Direct risk reduction and systemic risk management instruments are rather innovative and experience is limited. but for the RFI. The table shows which case studies are interested in applying EI for the three dimensions of risk reduction.

Table 4: Identified instruments with their links to the three dimensions of risk reduction

Instrument/Channel	Direct risk reduction	Indirect risk reduction	Systemic risk
Subsidies	Funding for relief and reconstruction Some evidence	Subsidize risk reduction measures; moral hazard Good evidence (S, D, AUS, Asia, Chamusca)	Subsidize insurance premiums, good evidence (EUSF)
Taxes and fees	Raise funding for relief and reconstruction Some evidence	Internalization of cost leads to efficiency gains • UK (Flood defence levy) • Po (mandatory land use charge) • Chamusca (Fuel tax for funding permanent forestry funds for fire protection activities) • Jucar (water taxes)	
Licences, permits and advanced market commitments		Trading rights and liabilities Advanced market commitment: government pays a premium for burned pine wood until 3 months after the fire (Chamusca)	
Payment for Ecosystem services		Integrate payment for DRM with PES; Emerging in climate adaptation • Po (water banking in agriculture to urban users) • Jucar (Water markets) • Chamusca (Payment for Ecosystem Services by WWF/Coca Cola)	
Water markets		Leads to efficiency increase in water use, good evidence , • Jucar	
Risk financing	Provides claim payments post-disaster helping to reduce economic risk, Good evidence (EUSF)	Moral hazard, good evidence • Po (mandatory insurance, subsidized) • Jucar (crop insurance) • Chamusca (wildfire forest insurance) • EU SDF (compensation , risk reduction and risk financing)	Index-based insurance manages up and down-side risk, limited evidence Chamusca

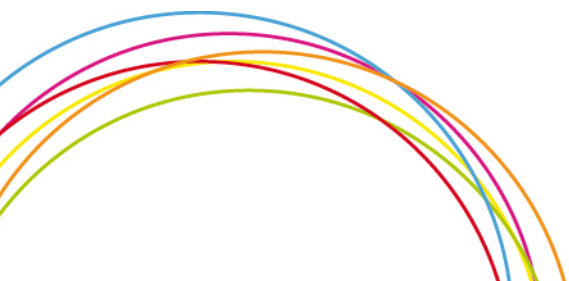
Note: Font shading indicates the following: black-theoretical link, red-level of evidence, blue-case study application

Our assessment of the EI categories according to the criteria "link to risk management", "attractiveness for typical MSP stakeholders", "experience and evidence" as well as "application in Enhance case studies" shows which EI will be more or less interesting for further assessment in the context of the ENHANCE project. E.g. the categories "licenses and permits" as well as "financial instruments" have been discarded for further analysis. The other categories revealed suitable EI as demonstrated in table 5 that will be further evaluated in the context of our case studies. Thus work step 5.2 takes into account EI such

as grants, tax reductions, land use taxes and fees, payments for ecosystem services, water markets and water pricing as well as the various risk financing instruments.

Table 5: Assessment of economic instruments for risk management and adaptation

Assessment criteria	Subsidies	Taxes	Licenses, permits, market commitments	Other Market Based Instruments	RFIs
Link to risk management (direct; indirect or systemic risk management)	Strong link	Medium link	Medium link	Medium link	Strong link
Attractiveness for typical MSP stakeholders (public (pu) / private (pr) / households (h)	High for pr & h Low for pu	Low for pr & h Medium for pu	Low to high for all	High PES for pu, water pricing and markets for pr/h	High (for sov. insurance and solidarity fund only pu and pr)
Experience and evidence	High	Medium	n.a.	Low	High
Application in Enhance case studies	High	Low	n.a.	Medium	High
Focus of further assessment	**Grants, tax reductions**	**Land use taxes & fees**	**Market commitments**	**PES, Water pricing / markets**	**Property insurance, crop and forest fire insurance, sov. insurance, risk-based solidarity fund**



6 References

Agrawala, S. and S. Fankhauser (eds.) (2008). Economic Aspects of Adaptation to Climate Change. Costs, Benefits and Policy Instruments, Paris, OECD.

Akintoye, A., Beck, M., and Hardcastle, C. (eds.) (2003).Public-Private Partnerships. Managing risks and opportunities. Blackwell Science. Oxford.

Association of British Insurers –ABI (2013). The future of flood insurance: what you need to know. Association of British Insurers, London.

Bjornlund, H. and McKay, J. (2002). Aspects of Water Markets for Developing Countries – Experiences from Australia, Chile and the US. Journal of Environment and Development Economics 7(4), 767–793

Botzen, W. J. W., Aerts, J. C. J. H. and van den Bergh J.C.J.M. (2009). Willingness of homeowners to mitigate climate risk through insurance, Ecological Economics, *68*(8-9), 2265-227

Botzen, W.J.W. and van den Bergh, J.C.J.M. (2009). Bounded rationality, climate risks, and insurance: Is there a market for natural disasters? Land Economics, 85(2): 265-278

Bräuninger, M., Butzengeiger-Geyer, S., Dlugolecki, A., Hochrainer, S., Köhler, M., Linnerooth-Bayer, J., Mechler, R., Michaelowa, A., Schulze, S. (2011). Application of economic instruments for adaptation to climate change. Report to the European Commission, Directorate General CLIMA, Brussels.

Burtraw, D. Szambelan, S. J. (2009). U.S. Emissions Trading Markets for SO2 and NOx. Discussion paper published by Resources for the Future.

Butzengeiger-Geyer, S. Michaelowa, A., Köhler, M., Stadelmann, M. (2011). Market mechanisms for adaptation to climate change - lessons from mitigation and a pathway to implementation. CIS Working Paper 71. Center for Comparative and International Studies (ETH Zurich and University of Zurich).

Carey, J., Sunding, D. and D. Zilberman (2002). Transaction costs and trading behavior in an immature water market. Environment and Development Economics 7:733– 50

Chambwera, M. Heal, G., Dubeux, C., Hallegatte, S., Leclerc, L., Markandya, A., McCarl, B., Mechler, R., Neumann, J. (2014). Chapter 17. Economics of Adaptation in: Field, Chris et al. (2014). IPCC WGII AR5: Impacts, Adaptation, and Vulnerability. Cambridge University Press, Cambridge

Charaklis, G.W. , R.C. Griffin and P.B. Bedient (1999). Improving the ability of water market to efficiently manage drought. Water Resources Research, 35(3), 823-831

Crichton, D. (2008). Role of insurance in reducing flood risk, The Geneva papers 33, 117–132

Deyle, R. E. and Smith, R. A. (2000). Risk-Based Taxation of Hazardous Land Development, Journal of the American Planning Association, 66(4), 421-434, DOI: 10.1080/01944360008976125

Dinar, A., M.W. Rosegrant y R. Meizen-Dick (1997). Water allocation mechanisms. World Bank, Policy Research Paper n. 1779. Washington, DC.

Diwakara, H. (2005). Water Markets in India: Economic and Institutional Aspects. Water Encyclopedia. 555–559.

European Commission (2009). Adapting to Climate Change: Towards a European Framework for Action. White Paper, Brussels: The Commission of the European Communities.

FAO (2013) Tourism investment in regulating and cultural ecosystem services, Rusenski Lom Park, Bulgaria. Case studies on Remuneration of Positive Externalities (RPE)/Payments for Environmental Services (PES), Prepared for the Multi-stakeholder dialogue 12-13

September 2013, FAO, Rome, http://www.fao.org/fileadmin/user_upload/pes-project/docs/FAO_RPE-PES_WWF_Bulgaria.pdf

Foresight (2012). Reducing Risks of Future Disasters: Priorities for Decision Makers, Final Project Report, The Government Office for Science, London.

Goodwin,B.K., Smith,V.H. (2013). What harm is done by subsidizing crop insurance? American Journal of Agricultural Economics 95 (2), 489-497

Grafton, R.Q., Landry, C., Libecap, G., McGlennon, S. O'Brien, B. (2010). An integrated assessment of water markets: Australia, Chile, China, South Africa and the USA. ICER Working Paper Series No. 32/2010, http://www.icer.it/docs/wp2010/ICERwp32-10.pdf

Griffin, R.C., Hsu, S.-H. (1993). The potential for water market efficiency when instream flows have value. American Journal of Agricultural Economics 75, 292–303

Gupta, S., Tirpak, D., Burger, N., Gupta, J., Höhne, N., Boncheva, A., Kanoan, G., Kolstad, C., Kruger, J., Michaelowa, A., Murase, S., Pershing, J., Saijo, T., Sari, A. (2007): Policies, Instruments and Co-operative Arrangements, in Metz, Bert; Davidson, Ogunlade; Bosch, Peter; Dave, Rutu; Meyer, Leo (eds): Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, p. 746-807

Harou, J.J., Pulido-Velazquez, M., Rosenberg, D.E., Medellin-Azuara, J., Lund, J.R., Howitt, R.E. (2009). Hydro-economic Models: Concepts, Design, Applications, and Future Prospects. J. of Hydrology, 375 (3-4), 627–643

Hess, U., Syroka, J. (2005) Risk, Vulnerability and Development. Presentation at BASIX Quarterly Review & Insurance Meeting, Hyderabad, 21st October.

Hoff, H., Warner, K. and Bouwer, L.M. (2005). The role of financial services in climate adaptation in developing countries. Vierteljahrshefte zur Wirtschaftsforschung, 74(2): 196-207

Howe, C.W., D.R. Schurmeier y D.W. Shaw (1986). Innovative approaches to water allocation: the potential for water markets. Water Resources Research , 22(4), 439-445

ICLEI (2010). Financing Climate Change Adaptation. Published by ICLEI USA.

IPCC (2012). Managing the risks of extreme events and disasters to advance climate change adaptation. A special report of working groups I and II of the intergovernmental panel on climate change. In: Field CB, Barros V, Stocker TF, Qin D, Dokken DJ, Ebi KL, Mastrandrea MD, Mach KJ, Plattner G-K, Allen SK, Tignor M, and Midgley PM (Eds.). Cambridge University Press: Cambridge, UK, and New York, NY, USA, p. 582.

IPCC (2014). Fifth Assessment Report Working Group II: Impacts, Adaptation, and Vulnerability. Cambridge University Press, Cambridge.

Kunreuther, H.C. (1996). Mitigating disaster losses through insurance. Journal of Risk and Uncertainty, 12(2-3): 171-187

Kunreuther, H. and Linnerooth-Bayer, J. (1999) The Financial Management of Catastrophic Flood Risks in Emerging Economy Countries, Paper Presented at Conference on Global Change and Catastrophic Risk Management Laxenburg, Austria: IIASA June 6-9, 1999.

Lal, P., Mitchell, T., Aldunce, P., Auld, H., Mechler, R. Miyan, A., Romano, L., Zakaria, S. (2012). Chapter 6. National Systems for Managing the Risks from Climate Extremes and Disasters. In: Intergovernmental Panel on Climate Change Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C. B., Barros, V., Stocker, T.F., Qin, D., Dokken, D., Ebi, K.L., Mastrandrea, M. D., Mach, K. J., Plattner, G.-K., Allen, S., Tignor, M. and P. M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Loch, A., Wheeler, S., Bjornlund, H., Beecham, S., Edwards, J., Zuo, A. and Shanahan, M. (2013). The role of water markets in climate change adaptation. National Climate Change Adaptation Research Facility. Gold Coast, Qld, Australia.

Lund, J.R. y M. Israel (1995). Water transfers in water resource systems. J. of Water Resour. Plng. and Mgmt., 121(2), 193-204

Lunder, E.K., Pettit, C.A.,and Teefy, J. (2012) *Tax Provisions to Assist with Disaster Recovery*, Congressional Research Service 7-5700

Mass, A. and Anderson, A. (1978). And the desert shall rejoice: conflict, growth and justice in arid environments. Cambridge, MIT Press.

Michel-Kerjan, E. and Kunreuther, H. (2011). Redesigning flood insurance, Science, 333, 408–409.

Mitchell, D. and Myers, M. (2013). Land Valuation and Taxation: Key Tools for Disaster Risk Management. Peer Reviewed Paper published by FIG Working Week 2013

Paudel, Y., Botzen, W.J.W. and Aerts, J.C.J.H. (2012). A comparative study of public–private catastrophe insurance systems: lessons from current practices, Geneva Papers on Risk and Insurance. Supplementary special issue on climate risk and insurance, 37(2), 257–285.

Picard, P. (2008). Natural disaster insurance and the equity-efficiency trade-off, Journal of Risk and Insurance, 75, 17–38.

Poussin, J., Botzen, W.J.W. and Aerts, J.C.J.H. (2013). Stimulating flood damage mitigation through insurance: An assessment of the French CatNat system. Environmental Hazards, 12(3-4): 258-277

Pulido-Velazquez, M., M. W. Jenkins, and J. R. Lund (2004). Economic values for conjunctive use and water banking in southern California, Water Resour. Res., 40(3), W03401

Pulido-Velazquez, M., Andreu, J., Sahuquillo, A., Pulido-Velazquez, D. (2008). Hydro-economic river basin modelling: The application of a holistic surface-groundwater model to assess opportunity costs of water use in Spain. Ecological Economics, 66(1), 51-65

Saliba, B. y D. Bush (1987). Water markets in theory and practice. Studies in water policy and management, n. 12. Boulder, Colorado, Westview Press.

Schwarze, R. and Wagner, G.G. (2007). The political economy of natural disaster insurance: Lessons from the failure of a proposed compulsory insurance scheme in Germany. European Environment, 17: 403-415

Spulber, N., Sabbaghi, A. (1994). Economics of Water Resources: From Regulation to Privatization. Kluwer Academic Publishers.

Sterner, T. (2003) Chapter 8 “Taxes”, Policy Instruments for Environmental and Natural Resource Management, Resources For The Future, Washington.

Suarez, P. and Linnerooth-Bayer, J. (2011). Insurance-related instruments for disaster risk reduction, Global Assessment Report on Disaster Risk Reduction. The United Nations Office for Disaster Risk Reduction, Geneva. Available at: http://www.preventionweb.net/english/hyogo/gar/2011/en/bgdocs/Suarez_&_Linnerooth-Bayer_2011.pdf

Surminski, S, Crick, F, Eldridge J, and Ward, B. (2013). Securing the future availability and affordability of home insurance in areas of flood risk, Policy Paper, Centre for Climate Change Economics and Policy, Leeds and London, UK, http://www.cccep.ac.uk/Publications/Policy/Papers/2013.aspx

Surminski, S. and Mysiak, J. (2013). ENHANCE Consortium’s response to Green paper on the insurance of natural and man-made disasters (COM (2013) 213 final). IVM, The Netherlands. Available at:

<http://ec.europa.eu/internal_market/consultations/2013/disasters-insurance/docs/contributions/registered-organisations/gri-lse_en.pdf>

Surminski, S. and Oramas-Dorta, D. (2013). Flood insurance schemes and climate adaptation in developing countries. International Journal of Disaster Risk Reduction, in Press, available online 28 October 2013.

Thieken, A.H., Petrow, T., Kreibich, H. and Merz, B. (2006). Insurability and mitigation of flood losses in private households in Germany, Risk Anal., 26(2), 383alit.

UNECE (2007). Recommendations on Payments for Ecosystem Services in Integrated Water Resources Management, Economic Commission for Europe, United Nations New York and Geneva, http://www.unece.org/fileadmin/DAM/env/water/publications/documents/PES_Recommendations_web.pdf

UNISDR (2011). Global Assessment Report on Disaster Risk Reduction: Revealing Risk, Redefining Development. Geneva: United Nations

WEF (2011). A vision for managing natural disaster risk, World Economic Forum April 2011, World Economic Forum, Cologny/Geneva, Switzerland; 2011, Section 7.3 http://www3.weforum.org/docs/WEF_VisionManagingNaturalDisaster_Proposal_2011.pdf