Flood risk exposure in Austria – options for bearing risk efficiently

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Abstract

Due to its topography, Austria is exposed to many natural hazards. Inadequate spatial planning aggravates natural exposure to risks, 12% of all buildings are potentially exposed to flooding almost 9% are considered to be at an extreme risk. Reinforcing precautionary measures is a prerequisite for an efficient risk management system that will be ready to meet future challenges. In an efficient risk management system the Austrian government's relief payments after catastrophic events should be substituted by a broad (mostly obligatory) insurance against natural hazards. The strong involvement of government in the provisions of precautionary measures against natural disasters and its role during emergencies should be better co-ordinated with private measures.

Keywords: Natural hazards, flood risk management, Austria

Introduction

Among the natural hazards that occur most frequently in Austria are floods, avalanches, storms, snow pressure and hail. In the past few years major flooding events caused significant damages (in 2002 about € 2.9 billion and in 2005 about € 0.6 billion). Earthquakes also present a great danger (above all in the south of Carinthia), but they rarely happen. Volcanic eruptions, storm flooding and tsunamis are major international threats that, however, do not directly affect Austria due to its geographical location. In industrialised countries such events mainly cause property damage, but particularly in developing countries, the death toll runs high every year. Natural disasters happen less frequently than catastrophic events caused by people (such as terrorist attacks, chemical accidents) but the damage (number of victims, property losses) is higher (*Swiss* Re, 2006).

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On a global scale, the trend in both the frequency of the occurrence of natural hazards and the damage of the events is rising. Changes in the world's climate nurse the fears that society will need to brace itself for more frequent and more serious climatic disasters. Human behaviour influences these natural processes to the worse (*IPPC*, 2007) and is at the same time resulting in an increasing vulnerability to natural hazards. Two developments are primarily responsible for this in developed countries: economic growth, which results in ever higher goods and property values, and the expansion of settlements and infrastructure area into at risk regions. In the less-developed countries these processes are eclipsed by the strong population growth.

Even if we assume that natural risk exposure did not change over time, this means that the economic damage potential is rising: In the last decade of the last century the per annum real growth rate of the capital stock of the Austrian economy was 2.6% (*Schwarz*, 2002). The sealed area of permanently populated space in Austria reached almost 6% in the year 2006. The increase in sealed area has remained constant for years at a daily level of land consumption of about five hectares, although the Austrian strategy for sustainability targets a level of one hectare per day (UBA, 2007).

The question is how private and public players can take these developments into account in their plans and adapt their behaviour correspondingly. Part of the efficient handling of natural hazards is keeping the level of damage low and, despite a certain risk exposure, to undertake as many economically profitable activities as possible. In this paper we will demonstrate how this goal can be achieved through a coordinated interweaving of public and private solutions. Starting point for our considerations is the current risk management system for dealing with floods. We will focus in detail on flooding because this natural hazard has caused in Austria considerable damage over the last few years.

In the analytical part of the paper we review the literature to identify the preconditions of an efficient system for the management of natural hazards from an economic point of view. In the following chapter we will make a proposal to optimally meet the following requirements during the three phases before, during and after a natural hazard occurs: In the first phase, farsighted damage prevention steps must be taken before a natural phenomenon occurs; in the second phase, as the event is occurring, mitigation measures must be realised quickly; in the third phase after the natural disaster happened, persons affected must be compensated at terms that are known in advance and the repairs and reconstruction has to be financed. An efficient risk management system helps ensure that steps are taken in all three phases to keep the total extent of damages as low as possible. An important instrument for doing this is the risk transfer system which distributes the financial consequences of uncertain events among a collective. Although this is only fully felt after the damage has occurred, the concrete characteristics have a great influence on the efforts potential victims make to prevent and reduce damages.

Investments in flood protection and flood exposure

Numerous means of preventing natural hazards are actually pure public goods (cf. *Mueller*, 2003, p. 18ff). Such goods are characterised by the fact that the exclusion of other households from consumption is only possible at a high cost or not at all. Theoretically, the value of public goods is derived from the willingness to pay of those households that benefit from this good. Another characteristic of public goods is that private households behave strategically. They indicate a low willingness to pay for a public good and can thus keep their financial contribution (e.g. for a dam) low. Therefore, the market does not provide public goods available at all, or only insufficiently. This deficit can only be overcome through public choice about the volume of the public good in question and a finance mechanism.

The Austrian legislature has solved this challenge in such a way that the costs of preventive protective constructions are not borne exclusively by the beneficiaries of the measures. Federal and provincial governments pay the largest share (up to 80% of total costs) of preventive measures. More than 200 Mio € per year have been spent on dams, plans and information systems that are important for assessing the hazards caused by natural phenomena during the last years. In addition, facilities such as fire brigades are co-financed so they are able to undertake disaster rescue missions more effectively.

There are detailed hazard zone maps for almost all the areas that are exposed to torrents and avalanches (*die.Wildbach und Lawinenverbauung*, no date). They show the different degrees of risk exposure and the processes that cause them. The corresponding maps are filed in the municipalities and form an important base for decisions about which areas should be excluded from certain uses. Analogue hazard zone maps are also being worked out for rivers but they do not cover all the territory yet.

The municipalities play an important role in damage prevention. By dedicating zones as being suitable for development they determine where buildings and infrastructure can be built. Hazard zone maps are information systems that are relatively difficult to put together and working them out requires a great deal of time. One result of this is that the proper plans were lacking in the past and local zoning did not give enough consideration to flood risk exposure. In addition, investigations following the floods of 2002 (cf. *Habersack* et al., 2004) discovered that existing maps had not been sufficiently considered in the local zoning, meaning that the number of properties at risk of flooding in Austria is very high. This was identified as one reason for the high level of flood damage in 2002 (cf. *Sinabell-Trimmel*, 2004).

To find out more about the extent of flood risk exposure, HORA (Austrian flood risk zones, "HOchwasserRisikoflächen Austria") was published in the summer of 2006. It is funded by the Federal Ministry of Agriculture, Forestry, Environment and Water Management and the Austrian Insurance Association VVO. With this information system it is now possible to better show the degree of flood risk exposure of individual objects throughout the entire territory. At the moment, the system is still lacking the precision of the hazard zone maps. The reduction of

flood risk due to dams and other protective measures are not yet accounted for. For many questions, however, this disadvantage is offset by its widespread availability and its accessibility over the internet with minimal efforts.

The extent of flood risk exposure in Austria is shown in Figure 1, disregarding the protective constructions like dams. It shows the potential risk exposure on a municipal level if protective steps that have already been taken should fail, for example if a dam breaks. The different colours of the municipalities depict how many properties (buildings with valid addresses) in the respective municipality are within the zones of 200-year flooding events. The darker the colour, the higher the portion of properties that is at risk. In Table 2 the corresponding figures are summarised on the level of the federal provinces. Additional information is settlement area and the percentage of sealed surfaces (streets, buildings, etc.) at the level of provinces. These data show that the number of properties in risk zones is very high in mountainous provinces where settlement concentrates along rivers in the valleys.

Altogether, slightly more than 242,000 properties are regarded as potentially at risk (they are within the zone of 200-year floods, should protective constructions fail). This corresponds to about 12% of the total. The majority of these (8%) are in the zone of 30-year events (zone 1 in Table 1), meaning they are potentially at a high risk.

In Austria, information is not being gathered systematically about the economic consequences of natural disasters. Although the number of properties at risk is now known well enough, we still do not know what the economic value of these properties is. The only source published regularly is the report of the disaster fund which finances public relief payments after catastrophes and precautionary measures. However, this report only lists the sum of the federal grants that have been awarded, without distinguishing between event categories (e.g. floods, avalanches) or breaking down the total damages. Knowledge about the economic effects of natural disasters is therefore very limited.

The floods of 2002 and 2005 are well documented (*Habersack* et al., 2004, *Rudolf-Miklau*, 2006, *Sinabell - Url*, 2006) and allow conclusions as to what portion of private damages is covered by state aid, insurance and private donations. Of all the claimants, an average of about 80% had their private damages covered; the “insured's share of the risk“ thus amounts on average to about a fifth of economic losses. For some individual households, however, the share of the damage they must carry can even be existence-threatening. On the other hand, depending on local governments, it is also possible to have the damages completely compensated.

Since different institutions are entrusted with the processes, and flooding can be caused both by natural streams that break their banks as well as by torrents and other waterways, it is not always possible to clearly allocate the steps that need to be taken for preventive flood protection. One example is that measures to improve rivers for shipping traffic are carried out simultaneously with flood protection improvements. The numbers presented are therefore confined to public investments that can be assigned unambiguously. In Table 1, the expenses

cited for flood protection measures are also compared to the number of properties that HORA identifies as being potentially at risk. The table shows that funds for preventive measures are not distributed evenly across the country. The largest expenditures per household or per capita are in the region with the lowest number of properties in flood risk zones (Burgenland) whereas investments in preventive measures are relatively low in the province with the most properties in risk zones (Niederösterreich).

Sinabell-Trimmel (2004) examined what factors the decisions were based on when judging the individual preventive protection measures. They determined that the criteria used to judge the cost-benefits of river engineering projects in the year 2004 did not reflect the standards of cost-benefit analysis. The estimate of the costs of projects was relatively reliable. However, the assessment of the benefits of river engineering projects was flawed because estimates were often based on standardised rates without recognising the actual conditions. In addition, the project assessments in question did not take external effects on downstream riparians into account.

Risk management and the risk transfer in Austria

There are some obvious imperfections in Austria's current risk management and risk transfer systems (cf. *Sinabell*, 2004; *Hyll – Vetters – Prettenthaler*, 2004; *Prettenthaler – Hyll – Türk – Vetters*, 2004). Particularly the coordination between risk management and the risk transfer system is inefficient. In addition, the risk transfer system exhibits the following deficits:

- The majority of private households is insufficiently protected against damages caused by natural hazards (including floods).
- In some Austrian provinces the indemnities paid by private insurances reduce the amount of state aid granted. This lessens people's incentive to take out private insurance policies.
- Many people who would like to take out insurance but live in risky zones (such as areas that were flooded within the past five years) cannot find an insurance company that is willing to cover the risk completely. If insurance policies do offer the coverage it is usually restricted by standard products – either to a percentage of the sum insured (e.g. 50%) or a flat sum (between 4,000 and 7,000 euros). Insurance companies set an upper limit to their total indemnity by including clauses against accumulated risks (e.g. 15 million euros per event). This means the actual benefits depend on the total number of people affected by a flood and are therefore not known in advance. Summing up, low cost damages occurring more frequently are covered by standard household policies fully while large damages occurring less frequently are not covered completely.

These observations indicate a market failure: Households in risk zones only look for insurance when they are – subjectively – worried enough. One reason for the low demand could be the subjective underestimation of the actual flood risk. HORA should have removed this problem,

yet a lack of information or limited interest still may lead to a huge gap between subjective and objective risk. At the same time, the insurance industry is only selling contracts where the policyholders are extremely underinsured. An important reason for this lies in the nature of the risk of flooding. Floods are different from conventional natural hazards primarily due to the large number of people simultaneously affected. This means that large sums must be paid out to cover damages within a short time. This can lead to side effects on a macro-economic level and. More important from the insurance industry point of view, large events can overstrain the liquidity of individual insurance companies. In the actuarial calculations the costs cannot be sufficiently distributed between the policyholders that suffered damages and those that did not. This means the risk can only partially be diversified. The part of the risk that cannot be diversified among the insured parties has to be covered by reinsurance policies – and these are usually expensive.

One way to make up for the failure of the market is for the federal government to provide disaster relief to the claimants. This is actually the solution which is used in Austria in the form of the disaster fund. Over the last few years roughly 80 million euros in state aid have been paid out annually to victims of disasters (*Sinabell – Url*, 2006). The analysis shows, however, that the government's efforts to take over the risk transfer system have only been partially effective: There is no legal claim to compensation, and the share of damage after accounting for indemnities and relief payments is very high in individual cases.

Financial assistance granted from the disaster fund and the budgets of the provinces are funded by tax money. Thus there is no connection between raising and distribution of the financial assistance on the one hand and the risk exposure of the persons affected on the other. This means that an important criterion of an efficient risk transfer system – insurance premiums that reflect the degree of the risk exposure – is not fulfilled (see section on the optimal insurance for natural hazards).

Providing financial relief after a disaster undermines precautionary activities taken by agents exposed to risks. The problem is reinforced by the fact that some federal provinces offset insurance benefits against relief payments. Agents don't make enough efforts to avoid damages and take out too low an insurance coverage. In many cases, the actual deductibles of the claimants are very high because of the combination of capped state aid and missing insurance coverage. The government should therefore withdraw from the risk transfer system after natural catastrophic events.

Requirements placed on an efficient risk management or risk transfer system

Risk management of natural hazards sums up all the measures for information and prevention or for damage reduction before and during a natural disaster. The risk transfer system, on the other hand, only describes the transfer of individual risks to risk collectives such as insurance companies or public relief funds. This can be a transfer system financed by taxes, as in the case of the disaster fund or, as in the case of storm insurance, an insurance system financed

by premium payments. The Austrian hail insurance can be described as a mixed system because private premium payments are subsidised by public transfers. Risk management and risk transfer are not independent of each other. The instruments from the two areas can either strengthen or weaken each other.

An efficient system of risk management and risk transfer for natural hazards must take into account the interaction between all the different instruments in all the phases of natural disasters:

During the **phase before the damage occurs** the potential level of damage should be kept low by adequate land use, building protective measures and through foresighted use. The potential damage can be greatly reduced by avoiding risk zones and by compliance with adequate building standards. The government's task is to provide the public goods. These include identifying the hazard zones, co-financing dams and other protective measures that help reduce the risk of damage. It also means running information systems and warning services, as well as the preventative support of fire brigades and emergency services. Another important responsibility of the state is the allocation of property rights, which also provides incentives for preventing damage. If owners of oil tanks are liable for damage caused by an oil leak then they will take the appropriate steps to prevent those damages should a disaster occur.

During the **phase when the damage is occurring** government and private parties can also help keep the damage level down. The federal government has the task of central coordination and makes its own facilities (e.g. the military) available to safeguard body and soul and minimise property damage. In this phase the civil services take on an important function (e.g. rescue squads and fire brigades) in averting dangers. Depending on the kind of natural event, the persons affected can help limit the damages by taking action on their own. When there is sufficient advance warning, damages can be considerably reduced, for example by evacuating people, moving vehicles out of the danger zone, putting up mobile dams, removing furniture and equipment from areas in the house that are at risk.

During the **phase after to the damage has occurred** it is important to remove the damages as quickly and as completely as possible, on terms which were laid down before the damage occurred. Both public bodies and private agents are involved in limiting damage during this phase as well. The government's task is to protect the population from a state of emergence, to quickly repair destroyed public infrastructure and to accelerate the resumption of business activities. The risk transfer system plays a central role during the phase after the damage has occurred because it pays out the compensations. However, the influence of the risk transfer system is not confined to this phase alone.

The role of risk-adequate premiums in risk transfer systems

When they take out insurance, households voluntarily exchange a possible loss due to property damage for the payment of a fixed insurance premium. Risk-averse households always take out full-coverage insurance under the following conditions:

Both the insurance company and the policyholders must know the value of the possible damage. The damage will not necessarily occur and individual damages do not happen at the same time, i.e. they are uncorrelated. The insured are all of the same risk class (cf. high/low). The extent of the damage cannot be influenced by the behaviour of the insured and, finally, the premiums have to be fair, i. e. the premium level corresponds to the expected damage. Deviations from these assumptions usually cause a household to reduce its targeted insurance coverage. Sales or administrative costs, for example, result in the insured voluntarily accepting deductibles (meaning they are underinsured). Nevertheless, all risk-averse households still take out insurance voluntarily under these circumstances (Laffont 1989). If there are clear features by which households can be discriminated beyond doubt as members of a specific risk class, insurers can calculate and offer corresponding risk adequate premiums for each risk type Thus, each risk type forms its own insurance pool and would therefore always buy full insurance coverage under the assumptions listed above. When it is not possible to distinguish between risk types the insurance premium must be set high and provided with a deductible (Rothschild – Stiglitz, 1976) otherwise the low risk types would not take out any insurance policies at all.

In the case of flood risk, since the flood information system was introduced both sides are completely informed about the insured's risk type concerning floods and earthquakes in the form of the frequency with which a property is flooded, e.g. high risk within the 10-year zone. Under symmetric information low risk households will not voluntarily join a risk pool with high risk households, rather a separating equilibrium with two risk pools will emerge.

By making flood insurance compulsory, the government can force low risks to take out a policy together with high risks or stipulate that flood damages be pooled with other natural hazards. Actually, this compulsion is only necessary when one of the assumptions mentioned above is violated. An example of such a violation would be if the premiums for a specific policy were not risk adequate. In this case there would be a redistribution of risks from low to high which households with low risk would not accept voluntarily.

Insurance policies are characterised by a fundamental conflict: They provide policy holders with financial safety but this influences their incentive to avoid damages before they occur (ex ante) or to reduce the damage during the situation or after it is over (ex post). When there is complete protection, for example, there is no incentive to take self-protective steps. This repercussion is called a "moral hazard" (Zweifel – Eisen, 2000).

Risk-adequate premiums increase the risk awareness of private households because properties that are in more danger or less protected also have a higher insurance premium.

This information already influences the choice of what properties may be built on and should also lead to a situation where the benefits of all ex ante protective measures (anchoring oil tanks, for example) are balanced against their costs. Risk-adequate premiums reward efficient protective measures, depending on how much it costs the insurer to monitor them, either with discounts (ex ante) or with deductibles (ex post). In so doing, they contribute to the efficient reduction of the risk of natural hazards (Shavell, 1979; Winter, 2000).

Alternative incentives can be offered with experienced based bonus malus systems, partial insurance exclusion or coinsurance clauses. Insurance policies with a coinsurance clause only cover a portion of the damage, starting at a damage amount that is agreed upon in advance. None of these incentives require monitoring the policyholder, and they automatically sanction behaviour that does not minimise damage by increasing premiums or restricting benefits.

The optimal insurance for natural hazards

Extensive natural phenomena, such as flooding, affect many households at the same time. Thus, individual damages are to a great extent or even completely correlated. The trade-off between affected and non-affected households that is typical of many other risks only works partially here, or it is eliminated at all. The correlation of the individual damages results in accumulated damage that cannot be diversified. Based on general considerations, Marshall (1974) developed a theory of two working insurance principles: (1) the transfer, or reserves principle and (2) the mutuality principle.

In the transfer or reserve principle, damage compensation is made by redistributing the premium earnings among the insured. Accumulated damages are protected in this system by reserves that are built up over the course of time. Aside from collective insurance, reinsurance or, more recently, catastrophe bonds and catastrophe options (Doherty, 2000) offer protection against fully correlated damages. The outermost limit to what an insurance company can pay is set by its equity capital.

In a system based on the mutuality principle, reserves only play a subordinate role. Instead, the insured are entitled to the surplus remaining in the collective insurance in years without damage claims and must make an additional payment in years when a disaster occurs. Thus in the mutuality system the damages are financed through a combination of premiums paid in advance and a subsequent sharing of the profit or loss. This construction enables protection against correlated risks within a collective insurance scheme. By taking out reinsurance, part of the non-diversifiable risk in a policy based on the mutuality principle can be ceded.

Insurance systems based on the transfer or reserve principle need a high portion of reinsurance as long as their own reserves are still low. They must pay risk premiums for this, and these can be high (Froot, 2001). In a theoretical model, Doherty – Dionne (1993) show that

only households that are extremely risk-averse would choose a full reinsurance and thus a transfer system. The remaining households would prefer to carry a part of the accumulated risk themselves and therefore would prefer a mutual insurance.

Insurance systems based on the reserve principle have an unpleasant macroeconomic side effect: Financing the accumulated damage by dissolving large reserves can put heavy pressure on the price of securities and result in losses of capital. At the same time, this causes interest rates to rise so that private clean-up and renovation work becomes more expensive – not only due to price increases caused by the high demand for clean-up and construction services but also because of the higher costs of financing this work (Doherty, 1997). In the mutual insurance system no reserves must be dissolved so that there is no pressure on the price of securities. Because of the withdrawal of purchasing power from the insured households (supplemental payments) other building activities that were planned before the natural phenomenon occurred might not be done, or the demand for construction work might be postponed. Both effects would mitigate the inflation for clean-up and construction services that takes place after a disaster. For a small open economy like Austria this effect is likely to be small.

Actually, there are only limited possibilities to take out insurance against loss or damage based on mutuality. For example, an insurance policy could be underwritten at an insurance society that only covers natural disasters, and that offers a corresponding profit/loss sharing in its insurance policies. At present, there is no such insurer in Austria. Another solution would be to take out an insurance policy with a conventional policy insurer in the form of a public limited liability company. However, such an insurance policy would have to replicate the appropriate profit and loss sharing based on the mutuality principle. A third possibility would be to take out a conventional insurance policy and at the same time purchase the shares of this insurance company; in this case, it would be ideal if this were a pure specialty insurer (Doherty – Dionne, 1993).

A proposal for a risk transfer system for natural hazards in Austria

At present, the government plays a central role in the Austrian risk transfer system for natural hazards. From an economic point of view, these costs have to be weighed against their benefits with respect to three dimensions: 1) encourage prevention, 2) trigger damage minimising activities while the event is occurring and 3) provide quick and complete compensation to the agreed-upon conditions.

The efforts made by the Austrian government to meet the first two objectives seem to be adequate. Its role in the risk transfer is not satisfactory because occasionally large individual damages are not covered (neither by indemnities nor by relief payments) and because private precautionary activities are de-motivated. Apart from equity considerations, in a first step, indemnities paid by insurance companies should not offset relief payments although overall compensations must not exceed the damage. Some households could be de-

motivated to buy an insurance coverage, if the neighbour gets coverage "for free" from the public relief fund. Public relief payments have a second undesirable side effect: they are tax funded and therefore the link between natural hazards and their economic risks is blurred. Risk premiums should reflect the exposure to hazards, this condition of an efficient risk management system is not met in the existing system.

If the government withdraws from the risk transfer system, there are two alternative systems: 1) The potential claimants carry the costs of the damages themselves or 2) an insurance market takes over the risk transfer. All theoretical insurance models show that self-insurance, i.e. version 1), results in heavier welfare losses. In these models, insurance solutions offer an optimal alternative to self-insurance. Insurance systems have the advantage that the optimal amount of damage prevention and damage-minimising activities are triggered through risk-adequate premiums. The instruments for this are premiums, discounts, deductibles and inspections that are appropriate for the danger potential.

Insurance policies based on the principle of mutuality combined with reinsurance are superior to other organisational forms of the insurance market because they can carry both diversified and non-diversified risk. Participation in non-diversifiable risk can be reduced with reinsurance, for which a risk premium is paid. When the reinsurance markets are efficient this system is superior to solutions in which reserves are built up over time or to a system where the government is liable for defaults because a government acting as the insurer of last resort effectively subsidizes the risk premium and thus violates the principle of risk-adequate premiums. The mutuality principle also makes upper limits for coverage superfluous. Limits to the total indemnity violate one of the three essential elements of an efficient risk transfer system because complete coverage is not offered under foreseeable conditions.

With hazard zone maps, HORA and other information systems, the prerequisites for calculating the distribution of damages from natural hazards are given. This should guarantee the supply of insurers to take over the risks. For an insurance market to be realised some barriers must be removed on the demand side. This includes too low subjective assessments of the risk exposure, the repression of demand by state aid and the lacking ability of low-income households to pay for risk-adequate insurance premiums. The first two obstacles can be overcome with a compulsory insurance in combination with a compulsory contract. This would make it possible for the government to credibly withdraw from providing financial relief after disasters.

The transition to a system with compulsory insurance of natural hazards is probably not possible without resistance. It would result in a subjective additional load on potential claimants who would be taking on the previous risk transfer that was partially based on tax benefits. Several elements of a specific insurance solution could help reduce this: Insurance premiums should only reflect the risks; there should be no redistribution between risk classes. By pooling different uncorrelated natural perils the number of persons affected that have compulsory insurance would rise and premiums could be offered less expensively if

necessary. The compulsory insurance would probably be more acceptable for many of the people if the tax burden were reduced at the same time.

Discussion and conclusions

The European Floods Directive will create an EU framework for flood risk management (CEC, 2006). It builds on and is closely coordinated and synchronised with the 2000 Water Framework Directive, the cornerstone of EU water protection policy. The Floods Directive adopted by Council and Parliament. It will require that Member States take a long-term planning approach to reducing flood risks in three stages (CEC, 2007): By 2011 Member States will undertake a preliminary flood risk assessment of their river basins and associated coastal zones. Where real risks of flood damage exist, they must by 2013 develop flood hazard maps and flood risk maps. By 2015 flood risk management plans must be drawn up for these zones. These plans are to include measures to reduce the probability of flooding and its potential consequences. They will address all phases of the flood risk management cycle but focus particularly on prevention, protection and preparedness (e.g. providing instructions to the public on what to do in the event of flooding).

Low transaction costs are an essential ingredient of an efficient system of risk transfer. In Austria, the information system HORA, established in 2006, is an important first step to meet the EU objectives on a better understanding of risk exposure due to floods. In its current state HORA suffers from a weaknesses: the precise risk exposure of objects cannot yet be determined automatically. Dams or retention basins are not yet fully accounted for and such constructions usually offer protection against 100-year events. Some properties that seem to be highly exposed (because they are in zone 1) may actually be protected against frequent events. In order to identify the precise risk exposure, additional information sources must be consulted. Therefore the transaction costs are still relatively high because premiums cannot be calculated automatically using only HORA. In future it will be necessary to integrate existing hazard maps from other sources into the system and further web applications must be implemented to make HORA an effective contracting tool for insurers.

Several factors make it unlikely that the proposal developed in this paper will be implemented in an unaltered way. First of all, there are legal hurdles for a system of obligatory insurance. Partial coverage against flood insurance as already offered by some firms is an indication that the market does not fail completely. To establish an obligatory insurance like in Spain or most Kantons of Switzerland bears considerable political risks. If a system of obligatory insurance had to be abandoned after being challenged at courts would do no good. Therefore a more likely solution is a system similar to the arrangement in the UK, in Italy and in Belgium where insurance of natural disasters is bundled with the fire insurance. Buying coverage against natural hazards would not be obligatory in a legal sense but quasi-obligatory for most owners of properties who need a fire insurance as a collateral.

For such a system to work, all major insurers must find an agreement with the relevant policy makers. Some policy makers might oppose an abolition of public relief payments after floods because helping people in need can be seen as an instrument to push popularity in the short run. Therefore it is unlikely that all policy makers support a withdrawal of the state from relief payments unanimously. Considering firms it is not likely that an obligatory or quasi-obligatory system of natural insurance is unanimously supported, either. A practical solution that is linked to existing fire policies would likely benefit the incumbent more than new entrants or firms aiming at increasing their market share with new products. Insurers that expect higher profits in the existing system are likely to oppose against such a solution or against a system outlined above. The new system to be established therefore should offer the possibilities for profits with innovative ancillary products.

The group of persons that is likely to be affected most by a system of a (quasi-)obligatory insurance (the owners of approximately 200,000 objects) is relatively small compared to the group of persons that would benefit from such a solution (several million tax payers). In many cases smaller interest groups are more effective to influence the policy making process in a way that is favourable to their interests. Therefore it is likely that the public savings in relief payments (approximately 80 Mio. € per annum) will not materialise. It is more likely that the funds now used for disaster relief payments will be allocated to subsidise premiums.

Insurers have a vital interest to transfer part of the risk to the state as the insurer of last resort. Homeowners and owners of businesses in high risk zones have a high interest to lobby for premium subsidies. Some people might find it 'fair' that those in zones without any risk contribute to a collective burden sharing system because of equity concerns. It is therefore not unlikely that in one way or another, premiums will be subsidised (either by the tax payer or by low-risk households). Granting premium subsidies does reduce the incentive for potential claimants to avoid damages. Nevertheless, premium subsidies seem to be the most suitable instrument for mitigating the burden of the compulsory insurance on disadvantaged groups. These include mainly the socially weak that have settled in hazard prone zones because of the favourable land prices. If premium subsidies have to be granted due to equity concerns, regional administrative bodies (primarily the local communities) should finance them because they were responsible for designating zones for development. However, if there is a premium subsidy it should only be temporarily granted and limited to existing properties. New developments would carry the price signal of high insurance premiums with them and thus ensure risk adequate behaviour.

Data presented in this paper show that large sums are spent for preventive measures in regions with relatively low risks. This finding supports results of the literature that preventive measures are not taken in a cost-effective manner. The European Floods Directive does not seem to be an instrument with a broad enough approach that forces governments of Member States to take cost-effective measures as the Water Framework Directive does. Depending on the way Member States implement the Floods Directive, national regulations

may turn out to put too much weight on an engineering way of decision making confined to technical effectiveness. After the establishment of a more efficient system of risk transfer in Austria, the next challenge would therefore be to coordinate the preventive measures like dams of retention basins. The estimated values of assets that are at risk in hazard zones, as assessed by the insurance industry are an essential input for optimal planning. This would make it possible to use public funds for protective constructions based on cost-benefit criteria.

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Table 1: Investments in flood prevention measures in Austria
real annual expenditurs (average 2001-2005) at prices 2005

	total	per household	per capita	per mio € gross value added	per object in a hazard zone[1])
Land	Mio €	€	€	€	€
Burgenland	20	191	71	4,206	2,387
Kärnten	23	104	41	1,904	1,465
Niederösterreich	28	47	18	884	383
Oberösterreich	28	52	20	841	768
Salzburg	26	128	51	1,784	1,329
Steiermark	28	62	24	1,102	1,056
Tirol	30	118	45	1,749	1,376
Vorarlberg	17	128	49	1,840	1,096
Wien	19	25	12	342	779
Austria	219	67	27	1,072	906

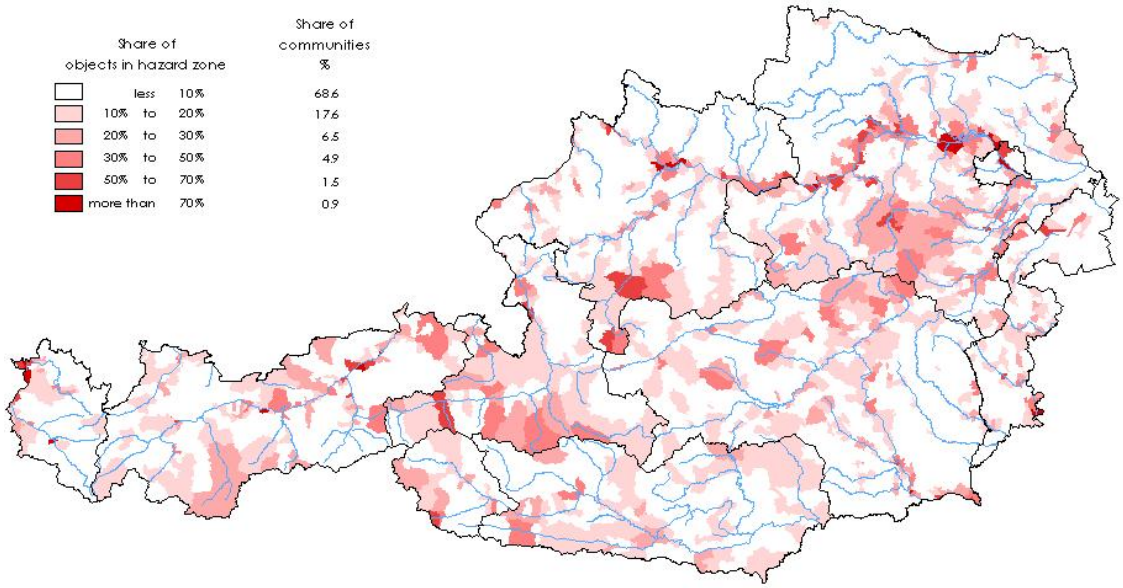
Sources: [1]) estimates based on *Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft* (2006C); Landesrechnungsabschlüsse (Budget-Ansatz 1/63). [2]) hazard zones according to HORA.

Table 2: Number of properties in hazard zones and sealed up area in the Austrian Länder 2005

	properties		settlement area		properties in risk zones[1])	
	total	in hazard zones	total	sealed up[2])	zone 1 to 3	zone 1 (high risk)
	number		1,000 km²	share in %	share in %	share in %
Burgenland	114,831	8,254	2.5	5.2	7.2	5.6
Kärnten	150,708	15,594	2.3	6.8	10.3	8.8
Niederösterreich	545,801	73,531	11.3	5.0	13.5	9.7
Oberösterreich	354,861	35,755	6.6	5.0	10.1	7.6
Salzburg	114,330	19,732	1.4	7.0	17.3	13.9
Steiermark	319,083	26,785	5.0	6.6	8.4	6.2
Tirol	153,196	22,044	1.5	7.9	14.4	11.4
Vorarlberg	88,181	15,527	0.6	8.0	17.6	15.5
Wien	174,407	24,829	0.3	28.0	14.2	6.2
Österreich	2,015,398	242,051	31.5	5.9	12.0	8.8

Source: Statistik Austria, Gebäudezählung 2001, *Land-, forst- und wasserwirtschaftliches Rechenzentrum GmbH* (2006); *Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft* (2006A). According to "Hochwasserrisikozonierung Austria – HORA" properties are potentially at risk ("potentiell gefährdet") ignoring protection due to dams and other constructions (*Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft*, 2006A, detailed definitions are available at http://www.hochwasserrisiko.at. – [1]) Number of properties in zone 1 (high risk: expected annual damage $T = 30$). Lower risks are in zone 2 ($T = 100$) and zone 3 ($T = 200$). – [2]) *Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft* (2006B).

Figure 1:Exposure of public, commercial and private properties to flood risks in Austria in 2005



Q: *Land-, forst- und wasserwirtschaftliches Rechenzentrum GmbH* (2006), own results.