The Impact of Climate Change on the Insurance Sector*

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One of the key tasks and core competencies of the insurance sector is to assess natural risks on a continuous basis and to manage the potential impacts of those risks. It is therefore not surprising that from the beginning, the insurance sector has been an active participant in modelling the impact of climate change and in identifying possible solutions. Before coming to our analysis of the relationship between the insurance sector and climate change, it is essential to explain key terms and basic possible impacts. For that reason, we start our paper with a brief summary of the causes of climate change and the most important groups of consequences, and a description of the European milestones on the road to the low-carbon economy. The impact of climate change on the insurance sector is explained through a German and an English example, in each case presenting and construing the assertions of a relevant study. In addition to an explanation of the differences in the approaches which are characteristic of each country, we also considered it important to outline the most important institutional viewpoints: in the German case, we mostly found examples for the insurance sector reacting in search of opportunities, while the English study is suitable to illustrate an approach that is more supervisory and risk-oriented in nature. To break new ground, we conclude our paper by addressing the likely impact of climate change on the Hungarian insurance sector.

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1. Causes and consequences of climate change

It is widely known that global warming can be pinpointed as the root cause of climate change. The cause of rising temperature can be identified precisely: the vast majority of researchers identifies the cause as the growing emissions of greenhouse gases, which is largely attributable to human activity (*Sachs 2015*). Over the past

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40 years, the issue of climate change has received increasing attention, as it became widely recognised that if everything were to continue as before, economic growth could be pushed to its limits in terms of emissions and resources as early as in the 21st century, which could potentially lead to economic collapse and political tensions.[1]

1.1. Growth in greenhouse gas emissions

Somewhat simplifying the scientific explanations, warming is accounted for by the greenhouse effect. The discovery of the effect in 1896 is attributed to the Swedish chemist *Svante (1896*). The phenomenon of the greenhouse effect can be described as follows: the wavelength of the thermal radiation (light) emitted by the Sun, which has a surface temperature of approximately 5,800 °C, has a maximum falling within the visible range, and the atmosphere of the Earth is virtually transparent at that wavelength. A large part of incident light is absorbed by the surface of the Earth, which will consequently warm to temperatures depending on the given season and latitude, and a number of other parameters. The Earth's own radiation, at temperatures almost always lower than 60 °C, produces a much smaller quantity of energy compared to the Sun, and its wavelength falls in the far infrared range, in which the atmosphere is opaque. Due to the opacity of the atmosphere, the heat cannot be radiated at the speed of light, and can thus be emitted into space as part of much slower heat transmission and convection processes. This process results in the warming of the atmosphere. This phenomenon requires the presence of gases in the atmosphere that are opaque to the thermal radiation of the planet. Such gases are referred to as greenhouse gases (GHGs). Normally, the atmosphere of the Earth also contains GHGs of natural origin, of which the most important are aqueous vapour, carbon dioxide, methane and ozone. Global warming is mostly attributed to the following greenhouse gases (*Figure 1*):

- *Carbon dioxide* is also a natural part of the atmosphere, and as such it is produced by the biological processes of organisms (breathing), and the mechanisms of volcanoes (combustion process) and oceans (release of bound carbon dioxide). As a result of human activity, the largest quantities of it are released to the atmosphere by burning fossil fuels (petroleum, natural gas and mineral coal). The largest emitters are, accordingly, power plants, industry and transportation, but the heating of buildings also carries significant weight. Rapid deforestation is another major contributor to the increase in the atmospheric concentration of carbon dioxide, which is naturally bonded by vegetation.

- *Methane*, another greenhouse gas, also occurs naturally primarily as a product of the decomposition processes of organic matter. In this case, the greatest threat

[1] This idea was first proposed by the authors of the now classic book "Limits to Growth" (*Meadows et al. 2004*), published in 1972.

is represented by emissions from the swamps and peat moors of melting tundra zones. As a result of human activity, the largest quantities of it are released to the atmosphere through the energy sector, agriculture (rice farming, livestock breeding), waste management and wastewater treatment, but significant quantities are also released in the course of petroleum and natural gas production, and from leaking natural gas transmission pipelines.

- *Nitrous oxide* is naturally produced during the decomposition of nitrogenous organisms, while as a result of human activity, the largest quantities of it are released to the atmosphere through the use of fertilisers, but emissions from thermal power stations and transportation are also significant.

- *Synthetic greenhouse gases*[2] are released to the atmosphere only through human activity, mostly as a result of industrial processes. They are released as solvents, coolants, blowing agents, filling material from fire extinguishers, degreasing agents, and as a core component of insulating materials used in buildings.

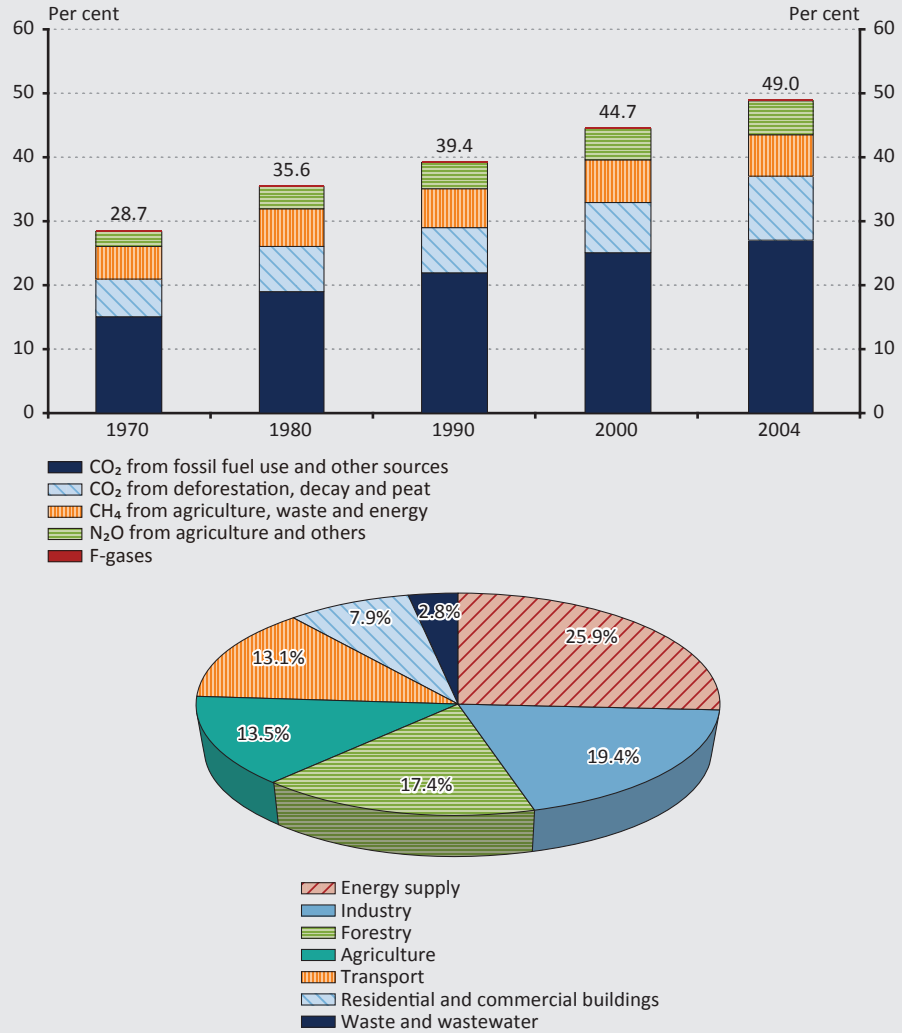
Another contribution to the greenhouse effect is made by natural aqueous vapour, and at that, the extent of its impact is greater than that of the materials listed above; however, its presence in the atmosphere is short (approximately 10 days), while that of the other three natural gases is long (10 to 200 years), and their processes of release and withdrawal from the atmosphere and their atmospheric concentration are largely influenced by human activities. Importantly, there are also natural processes counteracting the greenhouse effect, one of which is photosynthesis. As part of that, plants use the energy from sunlight to produce organic matter from water and the carbon dioxide contained in the air, releasing oxygen in the process.

1.2. Possible consequences

While the phenomenon of climate change has become widely accepted and scientifically demonstrated over the past decade (*Oreskes 2004*),[3] its possible consequences are far from being obvious. It was for that reason that the UN and the WMO (World Meteorological Organization) set up the IPCC (Intergovernmental Panel on Climate Change), which provides a suitable international scientific framework for research and discussions on the subject, and also has the capacity to produce materials to support the decisions of policymakers. In its fourth assessment report, the IPCC projects that by 2100, the global average temperature may rise by 1.1 to 6.4 °C depending on emissions of greenhouse gases (*IPCC 2015:10*). The reference point is the year 1750, and researchers consider a warming of 2°C

[2] The most important synthetic greenhouse gases include sulphur hexafluoride (SF6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).
[3] *Oreskes (2004)* supported this statement through an analysis of 928 scientific papers on climate change, published between 1993 and 2003.

Figure 1
Greenhouse gas emissions and share of different sectors[4]



Source: IPCC (2007:36).

relative to that date as the threshold of irreversibility (*National Geographic 2011*). In the acceleration of global warming, human activity (primarily energy production, industry, agricultural production and transportation) plays a major role (*Figure 1*).

[4] The first figure shows emissions of anthropogenic GHGs from 1970 to 2004, and the second the share of different sectors in total anthropogenic GHG emissions in 2004 in terms of CO_2-equivalent.

In an analysis of the possible and expected consequences of climate change, a distinction is appropriate between primarily environmental effects, the most important indirect effects and feedback generated by these, and the possible social, economic and political changes induced by the first two points.

1.2.1. Direct environmental effects of warming

The direct environmental effects of global warming are the most prominent and are generally perceivable particularly when extreme weather phenomena (storms, flooding and drought) occur. Direct effects are commonly identified as the following phenomena:

- changing seasons;
- increased local temperature peaks;
- shifts in climate zones;
- effects on seas (acidification, sea level rise, warming, shifting streams);
- withdrawal of glaciers;
- reduced polar ice covers (Artic, Antarctic);
- changed precipitation patterns: drought and flooding;
- effects on tropical cyclones;
- forest fires;
- effects on biodiversity.

Apparently, the effects of primary consequences may be extremely significant, while it is also true that it is precisely due to the ramified, leveraged and complex nature of these effects that it is very difficult to claim beyond reasonable doubt that, for instance, the increase in the local temperature peak in a given year was certainly and directly caused by global warming. However, through an assessment of the long-term data series analysed by researchers, the connection becomes obvious and scientifically demonstrable (*Oreskes 2004*).

1.2.2. Indirect physical effects

Direct effects induce additional changes; for instance, they impact the composition of organisms, and contribute to changes in permafrost (permanently frozen ground), and as a result of loosening, to the release of significant amounts of seabed methane to the atmosphere. Such phenomena can be considered as indirect effects, and although their consequences are difficult to foresee, these could also be significant.

1.2.3. Social, economic and political changes

The effects of climate change also concern social and economic arrangements. Possible social, economic and political consequences may include the following:

- global political consequences;
- environmental refugees (‘climate refugees’);

- health effects;
- direct and indirect economic losses (insured losses);
- effect on agriculture;
- effects on specific economic activities (energy industry, viticulture, tourism, etc.).

Due to climate change, new terms, such as 'climate refugee' referred to above, have also been coined in the social sciences. Initially, the term was only applied to residents of smaller islands in the Pacific, who were displaced by the sea level rise (and consequently deteriorating freshwater quality and crop safety), and commonly fled to the higher New Zealand. Subsequently, experts at the World Resources Institute (*Maddocks et al. 2015*) pointed out that the heat waves of unprecedented duration of up to several weeks, which have in recent years hit the Middle East with increasing frequency, and the massive urban inflow of herdsmen and farmers (approximately 1.5 million people) who lost their livelihoods due to the resulting water scarcity, were major contributions to the escalation of conflicts in Syria and the outbreak of civil war. According to the WRI, 14 out of the world's 33 countries most threatened by water scarcity are located in the Middle East and North Africa. As the population is rising rather rapidly in these countries, in the near future demand for water consumption will also increase at both the household and industry levels. At this point, however, it is unclear how those countries will meet this increasing demand, given that rivers have been falling spectacularly or are severely polluted. According to the forecast, over the next 25 years the water situation will deteriorate to such an extent that will threaten with a series of new economic, political and security crises, which may in turn lead to new conflicts and accelerating migration.

1.2.4. The goal is a shift towards a low-carbon economy

International organisations, including the European Union, have been setting key requirements for GHG emissions. In 2011, the Commission adopted its Roadmap for moving to a competitive low-carbon economy in 2050 (*European Commission 2011*). The Roadmap serves to ensure that across the EU, GHG emissions can be reduced by 80 per cent in terms of CO_2 equivalent by 2050 compared to 1990. In order to achieve set milestones, emissions must be reduced 40 per cent by 2030 and by 60 per cent by 2040. Every industry must make its contribution to the reduction so that the transition is viable and affordable. The objectives are ambitious and overarching, and concern virtually everyone. The signature of the Paris Agreement in 2015 (with 150 presidents and premiers in attendance) was a historic milestone in the fight against climate change. As one of the key commitments, signatories (for the first time in history, all 198 signatory countries) undertook to cap warming at 2 °C, while making efforts to limit it to only 1.5 °C.

2. The relationship of climate change and insurance

Through an analysis (*Botzen 2013:37*) of the developments in losses (both insured and uninsured) caused by natural disasters, the significance of weather-related risks for the insurance sector becomes obvious. The figures clearly show an increase in claim amounts. As regards extreme storms, floods and droughts, individual countries show varying degrees of vulnerability according to their location and geographical circumstances, but there is essentially no country that is entirely immune to these effects. Apart from the payment of damages to the insured following the occurrence of disasters, insurance companies may play an equally important role in mitigating risk and promoting adaptation (e.g. by the design of incentives that point in the right direction). It is therefore not surprising that several countries have made serious efforts to identify and analyse the risks and their relationship with the insurance sector.

We consider it important to present the diverging viewpoints through the opinions of insurance operators in various countries. First, a global approach is presented from the perspective of the Bank of England Prudential Regulation Authority (PRA), which is also responsible for the supervision of the UK insurance market, followed by an account of the international initiative Principles for Sustainable Insurance (PSI), and then an analysis of the relationship between the German insurance sector and climate change from the perspective of the GDV (German Insurance Association). Finally, our own insights are also presented in the context of the situation in Hungary.

2.1. Climate change and the global insurance market from the perspective of the UK supervisory authority for insurance

A summary of the impact of climate change on the UK insurance sector was given by the Bank of England in a publication released in 2015 (*PRA 2015*), the background to which was provided by consultations with 30 insurance companies, four roundtable discussions, and a number of interviews with experts. The Bank of England is primarily concerned with the issue in its capacity as Prudential Regulatory Authority (PRA). The PRA is tasked with the prudential supervision of financial institutions and insurance companies, and supervisory responsibility requires it to facilitate the safe and stable operation of the sectors supervised, so as to make a contribution to protecting the interests of the insured.

2.1.1. Risk factors relevant to the insurance sector

The risks associated with climate change and relevant to the insurance sector can be classified into the following broad risk factors:

- *Physical risks:* such risks are generally associated with weather (storms, floods, hailstorms), and their impacts are usually proportional to the incidents occurring,

whether involving damage to property or its subsequent consequences (disruption of supply chains, scarcity of specific resources, etc.).

- *Transition risks:* these are financial risks associated with decarbonisation, i.e. the transition of the economy to lower levels of carbon dioxide emissions. For insurance companies, this is mainly about the risks in the re-pricing (loss of market value) of assets invested in carbon-intensive sectors. To a lesser extent, this also includes, for instance, expected reductions in insurance premiums from customers operating in carbon-intensive sectors.

- *Liability risks:* these risks arise from parties who have suffered damage from the negative impacts of climate change, and then seek to pass some or all of the losses to parties who are believed to be responsible for the occurrence of the incident. Where such claims are successful, insurance companies may be required to cover some of the costs, primarily in the context of professional indemnity or directors' and officers' insurance.

- In our view, a separate factor is comprised of risks associated with life and health; however, their changes are more complex compared to the first three factors, and the quantification of their impacts requires longer observation times.

The study prepared by the UK supervisory authority draws the following key conclusions in respect of the first three risk factors:

Physical risks

- Out of the three risk factors, physical risk has the greatest relevance to insurance companies' balance sheets through its impact on provisions and liabilities. The use of the most important means of risk management (catastrophe risk modelling, portfolio diversification on both the asset and liability side, alternative risk transfers, reinsurance arrangements, and short-term contracts) suggests that insurers are reasonably well equipped to manage physical risks. Provided that premiums are calculated adequately, the management of physical risks is also supported by the specific production cycle of insurance, i.e. the fact that premiums are paid before benefits, which reduces liquidity risk. The stability of operation is also supported by robust regulatory capital requirements, designed to ensure the adequacy of insurers' financial resources also in the event of incidents.

- Over the longer term, the increased levels of risk are likely to have important consequences for market-based mechanisms of risk transfer, and the evolving role of actuarial assumptions about alternative capital and exposure to risk. This includes correlation both across climate hazards and also between risks on the asset and liability sides of insurers' balance sheets.

- Physical risks are likely to become increasingly relevant to insurance business models over time, also impacting the asset side of balance sheets. Particularly investments in real estate and assets managed over the longer term may be affected, to the extent that such investments rely on high carbon emission scenarios, or business models of that nature. Investor sentiment and expectations relating to climate change may also change in the nearer term, and there may also be questions as to the extent of such changes, which may, therefore, also have an impact on assets measured at market value. In negative scenarios, depending on the impact of climate change, unhedgeable risks may also arise according to the study.

- The impact of physical risks appears to be lower where insurers have closer links to the scientific community and are capable of considering multiple perspectives on risk, including the development of scenarios and the use of stress tests and other means.

Transition risks

- The global transition to a lower-carbon economy may have a negative impact on insurance companies via two channels: through their investments in carbon-intensive assets (declining asset prices), and also through reduced insurance premiums from customers employing carbon-intensive technologies. This group of customers have a vital interest in deliberate preparations, and the identification of possible strategies and good practices.

- The PRA views transition risk and more specifically the speed of transition as an important area for further assessment. Transition risk can be mitigated where insurers actively consider potential implications of a global transition to a lower-carbon economy in their business plans and investment strategies.

Liability risks

- The PRA views liability risks to be most relevant to general insurers through the possibility of increased third-party liability claims. To a large extent, this risk factor is speculative in nature: historical events have shown that liability claims can be less predictable and more disruptive to the insurance industry, given the possibility of significant and unforeseen claims rapidly increasing over time, which could even be triggered by a few uncommon court rulings. On the other hand, no decline is expected in customers' need for insurance cover for the management of their exposures, which could increase the overall profit of the business.

- The PRA considers the impact of liability risks to be lower where insurance companies follow a prudential policy and practice in risk taking, adopt written guidelines on the risks associated with climate change and exposures, and continually assess their impact.

2.1.2. Towards a low-carbon economy: supervisory means of supporting transition

Financial regulators and central banks are beginning to take action on the management of systemic environmental risks associated with climate change. The United Nations Environment Programme (*UNEP 2012*) recommended a number of innovative practices to decision-makers ranging from regular climate reporting (*CAR 2014*) to the introduction of the Green Credit Guidelines by China's CRBC (*CRBC 2012*). Regulators of the insurance sector are also exploring the specific implications of climate change-related risks. Accordingly, in 2013 the National Association of Insurance Commissioners (NAIC) in the US adopted revisions to the Financial Condition Examiners Handbook to support examiners in their quantitative assessment of any potential impact of climate change on solvency of insurance companies (*NAIC 2008*). The PRA primarily aims to promote firms' resilience to climate-change risks and support the financial sector in making an orderly transition to a lower carbon economy. This will focus on four activities, as follows:

- *International collaboration:* As with other systemic risks, continual collaboration among financial regulators and other related bodies will also be important in this regard. Changes in the disclosure requirements of even a single jurisdiction could significantly affect transition risks through capital flows in various segments of financial markets. The PRA's international collaboration on climate change to date has focused on participating in the United Nations Environment Programme (UNEP)-led initiative 'Inquiry on the Design of a Sustainable Financial System'.[5] The PRA expects continued international collaboration on these issues to be an important part of its initiative. The PRA considers the facilitation work of the International Finance Corporation (IFC) as part of the 'Sustainable Banking Network' (SBN)[6] as a model to follow, which makes a significant contribution to collective learning amongst banking regulators on sustainability-related issues. An analogous network for insurance regulators and associations interested in sustainable insurance policies, guidelines and practices may also be worthy of further consideration.

- *Research:* The PRA's work on climate change research is at an early stage; the knowledge needed to advance the PRA's above approach is not fully available at this point. The PRA intends to explore research questions most relevant to the impact of climate change on microprudential supervision, including physical and transition risks. The PRA expects these to be considered as part of the Bank of England's wider research agenda.

[5] For more details about studies on the subject, see http://web.unep.org/inquiry.
[6] Established in 2012, the Sustainable Banking Network (SBN) is an informal and exclusive group of banking regulators and associations, which focuses its interest on sustainable banking policies, guidelines and practices.

- *Dialogue and engagement:* An important new feature for PRA is a climate change adaptation report, which can be produced on an ad-hoc basis relying on substantial dialogue with PRA-regulated insurance companies and wider stakeholders. When carried out on a regular basis, this could support an appropriate level of continued dialogue and engagement to participation.

- *Insurance supervision:* The PRA intends to take a judgement-based, forward-looking and proportionate approach to insurance supervision, including the use of business model analysis to examine the viability and sustainability of firms' business plans. Under the Solvency II regime, which came into force on 1 January 2016, firms are required to hold regulatory capital calibrated to a 1 in 200 VaR over a one-year time horizon and undertake a forward-looking review of risks through their Own Risk and Solvency Assessment (ORSA). Additionally, the PRA will give further consideration as to how best to incorporate the identified climate change risk factors into its existing framework, including its supervisory approach. A review of the PRA's business model analysis and stress-testing framework could provide for an ongoing assessment of climate change risk factors. It may be important to build in-house technical expertise to support supervisors in their assessment of climate change risks and in developing a better understanding of the effects on insurers. Additionally, the supervisory authority may also arrange for the incorporation of identified and assessed climate change risk factors into models in the course of thematic reviews of firm ORSAs.

2.1.3. New opportunities for the insurance sector

In addition to risks, the study also mentions new opportunities for the insurance sector. Given the role of insurance in providing protection and risk transfer, the industry could clearly have an important role in *supporting adaptation to climate change*. Responses to the PRA's survey, and wider discussions, highlighted a number of opportunities in this area:

- Improving awareness of climate change risks and providing expert advice to prevent and mitigate risks and losses may be particularly useful in the case of physical risks to property-related assets. While some insurers already provide guidance to customers on resilience to natural catastrophes or floods, the scope of that support should be broadened. One such opportunity is to influence regulations that are in place to improve building codes, to strengthen flood defences, or to reduce climate hazards by other means.

- Developing innovative risk transfer mechanisms as part of broader risk management solutions to help under-insured or uninsured communities and economies to meet the challenges of climate change. This could also include

providing technical assistance to innovative public as well as private initiatives, such as the CCRIF[7] or the ARC.[8]

- There are also opportunities for insurance firms to develop new products. In particular, these relate to the transition to a lower-carbon economy in areas such as renewable energy project insurance, including increasing demand for insurance coverage for design and construction risk as well as performance risk, such as providing cover for income shortfalls from solar farms due to changing weather patterns.

- Existing environmental insurance offerings ('green products') may also provide opportunities for insurers to incentivise behaviour change that reduces carbon emissions. Good examples in this area include 'pay-as-you-go' motor insurance policies, which incentivise a reduction in the usage of cars, while also encouraging greater energy efficiency.

- The insurance industry is traditionally a significant and active institutional investor. Following the examples of other institutional investors may be particularly productive in the field of investments in 'Green Bonds', i.e. debt instruments to fund projects that have positive environmental and/or climate change benefits. In addition to exploiting business opportunities, insurers could play a role shaping and driving the growth of these types of products. Investing in flood defences, or other infrastructure to support adaptation, could be another example of generating suitable risk-adjusted return profiles.

- Through industry associations, making climate change-related investment commitments. For example, at the UN Climate Summit in September 2014, the ICMIF[9] and the IIS[10] jointly committed to doubling the industry investment in climate-smart investments from that year's USD 42 billion to USD 84 billion by the end of 2015.

More widely, compared to other industries insurers arguably have clear views on their role in driving a wider societal response to climate change. A greater knowledge base, the nature of the business, indemnification for damage and the resulting higher sensitivity to risk make the insurance sector more open to the issue of climate change. This is taking a variety of forms, including participation in green initiatives, such as ClimateWise,[11] the global insurance industry's leadership

[7] Caribbean Catastrophe Risk Insurance Facility.
[8] African Risk Capacity.
[9] International Cooperative and Mutual Insurance Federation.
[10] International Insurance Society.
[11] The US initiative aims to provide assistance for local leaders with the development of strategies on adapting to the effects of climate change. More details: http://climatewise.org/.

group driving action on climate change risk, or becoming a signatory to the PSI[12], a specific part of the global initiative UNEP FI.[13]

2.2. Principles for sustainable insurance – a global initiative

PSI (Principles for Sustainable Insurance) is an initiative for the insurance sector launched in 2015 as part of the United Nations Environment Programme Finance Initiative (UNEP FI). According to the initiative, sustainable insurance is an approach that aims to mitigate risk, seek innovative solutions and improve business performance with a view to meeting environmental, social and economic challenges. The initiative highlights four principles, which it considers the focal points of sustainability in insurance. The principles are the following:

1. Embed relevant ESG issues[14] in the decision-making processes of the insurance business.

2. Work together with clients and business partners to raise awareness of environmental, social and governance challenges, and to manage risks and develop solutions.

3. Work together with governments, regulators and other key stakeholders to promote widespread initiatives across society on environmental, social and governance issues.

4. Demonstrate accountability and transparency in the regular public disclosure of progress in implementing the Principles.

To date, the principles have been signed by close to a hundred international insurers and reinsurers (*UNEP 2012*), some of which also have significant shares of the Hungarian market. Not surprisingly, reinsurers are particularly active in this field. Namely, reinsurers play an important role in analysing available historical data, modelling likely effects, and integrating those effects into risk management systems. By doing so, they make a significant contribution to enhancing knowledge about climate change to a scientific standard. In the context of climate change, other than reducing their own ecological footprint, both reinsurers and insurers are actively working on the development of products that help customers mitigate climate hazards and adapt to climate change.

[12] Principles for Sustainable Insurance. For more details, see http://www.unepfi.org/psi/the-principles/.
[13] United Nations Environment Programme Finance Initiative (UNEP FI).
[14] Environmental, social and governance issues understood collectively as they concern sustainability.

2.3. Adaptation by the German insurance market: a practical approach and cooperation

We consider an account of the German example to be relevant in several respects. Apart from geographical proximity and similarity of climate, its approach, which is more practical compared to the UK, and its more local mindset, could be a model for Hungary as well.

2.3.1. Problem identification and social dialogue

From 2009 onwards, the German Insurance Association (GDV) was increasingly concerned with the phenomenon of climate change, and by 2011, it produced the studies which shape thinking to this day. Initially, these focused on the following questions:

- What changes does Germany need to anticipate due to the climate change?
- How can the consequences of climate change be insured in the future?

Based on an outlook to 2100, prepared with contributions from leading climate researchers (*GDV 2011*),[15] the Association modeled specific risk experiences for individual types of natural disasters and prominent risks (floods, storms and hailstorms) that depend or are strongly influenced by meteorological factors. According to the main findings of the study, an increase in hailstorms is to be expected in the summer months. In particular, areas in Western Germany must anticipate a significant increase in damage caused by storms and flooding. Extreme weather events will become increasingly intense, and they will cause a significantly higher amount of damage. The study provided detailed maps to illustrate the likely impacts on specific areas of Germany. At the same time, the results suggest that the insurance sector, although at a higher level of premiums, will retain its ability to cover the risks emerging as a result of climate change.

These models offered a unique tool to the German insurance market, the leaders of which considered that the problems foreseen could only be tackled through joint efforts. To that end, they put forward firm recommendations for other economic and social actors in Germany. Key recommendations for the most important groups addressed are the following:

- various levels of policy:
  - participants in federal policy (earliest possible integration of the industry in decision-making, promotion of climate research, fixing the insurance tax on

[15] The participants invited represented the following institutes: Potsdam-Institut für Klimafolgenforschung (PIK), Freie Universität Berlin (FUB), Universität zu Köln (UK), Institut für Angewandte Wasserwirtschaft und Geoinformatik (IAWG).

specific hazards at a low rate, following the Bavarian model of a joint campaign by the state and insurers for increased security, etc.);

– participants in federal state policy (prohibition on construction in flood-prone areas, facilitation of information flow on weather extremes, coordinated action by federal states, etc.);

– municipal governments (reservation of land for backwater and flood areas);

- representatives of specific professions, in particular planners and architects (storm-resistant roof structures, requirements for doors and windows to provide higher water-tightness performance, use of materials for energy efficiency redevelopment that withstand hailstorms and other natural hazards, etc.);
- economic operators (use of energy efficient technologies, integration of the insurance sector in technological development);
- house owners (planning with the future in mind, wise use of alternative energy sources, acquisition and application of preventive and protective competences, knowledge of tasks depending on local flood hazards, attention to the resistance and water-tightness of doors and windows, etc.).

Apparently, adaptation in the German insurance sector had already begun before 2010. The adaptation process to date can be divided into distinct phases: it started with a more passive learning phase, followed by a more active development phase that resulted in activity for participants in the insurance sector and increased authority for the sector as a whole, and culminated in a role involving the setting of requirements for the environment and demonstrating competencies. A few steps of this process, which also bear relevance to the Hungarian market, deserve to be highlighted.

1. *Every beginning is difficult:* A substantial part of the base studies on climate change that are relevant to the insurance sector were carried out in 2008–2011. Subsequent studies were more concerned with the clarification of details, additions, and the promotion of product development. By 2011, this led to a situation in which insurers started to view climate change more as an opportunity to increase markets and revenues (*Schmitt 2011*). This points to the possibility of making returns on competency development relating to climate change. However, this 'investment' should be handled at the association level rather than at the level of individual insurers, because this will induce the change of attitude that may ultimately result in higher demand for 'green' insurance products. Obviously, in this case costs will also be spread, with the possibility to build a shared knowledge base.

2. *Search for allies:* Some of the base studies are associated with recognised universities and research institutes. As German society has a traditional appreciation of knowledge, the insurance sector's learning and acquisition of competencies in the field of climate change was seen as a genuine process from the beginning.

3. *Self-confidence of the insurance sector:* From a Hungarian perspective, it may appear odd that representatives of the German insurance sector made specific recommendations and demands by publicly addressing certain groups of policymakers, economic operators, professions and society at the same time. This self-confidence was based partly on the knowledge obtained, and partly on the sober consideration, 'If you can't stop it, lead it.'

4. *There may be bumps:* The learning process was strongly inspired by the beginning of the energy transition (Energiewende). In Germany, the first decision to phase out nuclear energy was adopted as early as in 2000, followed by legislation in 2002, and accompanied by the development of renewable energy sources on a large scale. In this accelerating process, the German insurance market initially fell behind, causing insurability problems for power plants, and capacity problems for insurers. Although today the process is supported by the insurance sector both through its insurance capacity and as an investor, participants do not want to make the same mistake again.

2.3.2. Lessons learned from a snapshot

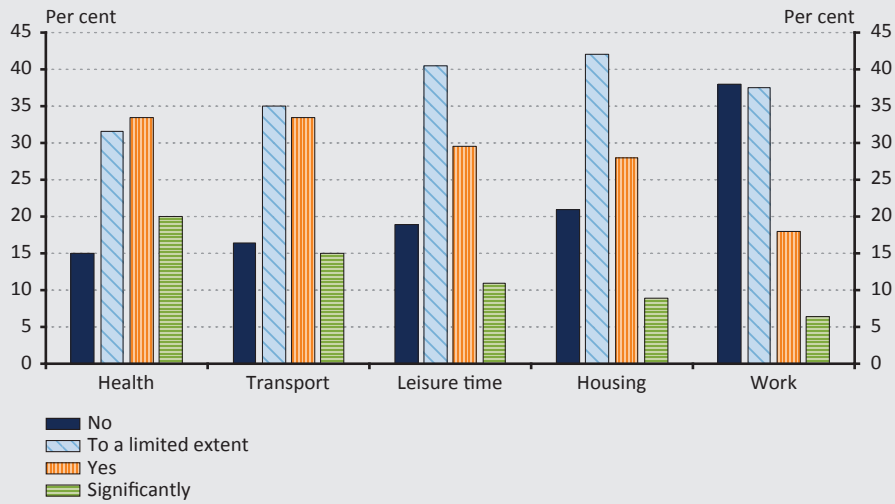
In addition to the foregoing, there have been studies on the likely developments in supply and demand, 'green' products, and the factors supporting such products. A study by the Institut für Technologie of Karlsruhe (*KIT 2011*) reviewed the 'green' products of some global insurance operators, and also carried out an in-depth analysis of agricultural insurance as well as insurance products related to human health, leisure time, housing and transportation in German-speaking Europe (Germany, Austria and Switzerland). The research institute found that for the most part, Germany has products available to support the adaptation to climate change and the avoidance of undesired effects. On the other hand, it also found that people making a living from agriculture, and retail customers had rather limited awareness of the products that could be used effectively in the face of climate change.

Apart from some Austrian/Swiss plant insurance schemes covering multiple risks, including drought, the authors of the study find particular perspective in building insurance products that index the maximum damages payable on cumulated risks.[16] Additionally, the study also discusses a household survey that covered the whole of Germany and examined the acceptance of novel features in certain insurance

[16] Simultaneous occurrence of interrelated incidents associated with the large number of risks.

products, attitudes to climate change, and the willingness and actions to make provisions. The evaluation of the data showed a significant coincidence in the extent to which respondents considered themselves, and the whole country, to be at risk. The largest percentage of respondents pointed to the effect of climate change on health, and that may also be where the state may have the most prominent role to play (*Figure 2*). Another key finding is that the increase observed in the confidence in public and private health institutions leads to a slight decrease in perceived risk.

Figure 2
Effect of climate change on specific areas of life in Germany[17]



Source: KIT (2011:66).

Given that transport is one of the largest GHG emitters in Germany as well, the survey included a question on pay-as-you-drive insurance. The question was as follows: "Car usage is responsible for 12 per cent of Germany's CO_2 emissions. To reduce that rate, all of us should drive less. The insurance sector can promote this by calculating car insurance premiums based on the distance driven. GPS technology enables both your location and speed to be identified. Drivers with relative low mileages who observe speed limits and drive mainly on roads involving a low risk of accidents could have their insurance premiums reduced by up to 50 per cent. Would such a car insurance possibly of interest to you?" 27.8 per cent of respondents gave a positive answer, 54.1 per cent rejected the proposal on grounds of constant monitoring, and 12.2 per cent would prefer to pay fixed premiums. 6 per cent of respondents reported not driving or not having a car. According to the study, the acceptance rate of the service could have been higher if less emphasis had been

[17] Sectors from left to right: Health, Transport, Leisure time/Holidays, Housing, Work. The height of each bar represents the percentage of those agreeing.

placed on the monitoring feature, and the question had focused more on technical details. At the same time, the result also shows that potential users' concerns about data protection must be taken seriously.

Owing to its high sensitivity to weather, agricultural insurance is an area that receives particular attention, and in which Germany is not a prominent leader. In this regard, the study also gave a broader international outlook. The study found that the way forward may lie in product development based on packaged risks rather than specific individual risks.

It will be apparent from the foregoing that the issue of climate change is of strategic importance to the German insurance sector. The German Insurance Association (GDV) has undertaken an active role and taken the initiative in shaping social discourse and mobilising the demand side, while it also supports insurers in helping their customers to adapt to climate change and avoid undesired effects.

3. Hungary

3.1. Hungary and climate change

In Hungary, the beginning of climate change research dates back to the summer of 2003, marking the launch of Project VAHAVA (Change, Impact, Response) lead by Academy member István Láng. Project VAHAVA culminated in the development of the first National Climate Change Strategy (*NCCS 2006*), which the Parliament adopted in 2008. NCCS-1 covered the period 2008–2025 and comprised as one of its main components the start of design work on the Green Investment Scheme (ZBR) to provide funding for investments that improve energy efficiency and use renewable energy sources. The first review of NCCS-1 was carried out in 2012, as part of which the second National Climate Change Strategy was drafted and was subsequently subject to wide public consultation. The material was approved by government on 20 May 2015, and on 2 June 2015 it was submitted to the Parliament (*NCCS-2 2015*), but has been off the Parliament's agenda ever since. The logic of NCCS-2 rests on the following main pillars:

- Examination of the Hungarian components of GHG emissions, the primary cause of climate change, and setting out responses. This chiefly means decarbonisation, i.e. a transition to a low-carbon economy. The details of that transition are specified in the National Decarbonisation Roadmap.
- Modelling climate change scenarios: an outlook on likely conditions in terms of temperature and precipitation, and on changes in waters, soil, forests, biodiversity, and the health of the population. Apart from modelling, the material also takes account of obvious adaptation scenarios as part of the National Adaptation Strategy.

• The details of awareness-raising work are set out in the awareness-raising plan 'Partnership for Climate'.

The NCCS-2 discussion paper (*NCCS 2013:17*) gives the following summary of the climate change tendencies foreseen in Hungary up to 2090: "Climate change foreseen in Hungary: Throughout the country, a 1 to 2.5-degree increase in the annual average temperature is likely, with a somewhat more intense warming to be expected in winter and summer compared to the transitional seasons. Within temperature extremes, the number of frost days could decrease by approximately 35 per cent, while the number of heat waves, particularly in the central and north-eastern regions of the country, could increase by more than 30 days. Shorter-term estimates for precipitation, with an outlook to 2050, involve a great deal of uncertainty without any significant changes over that time horizon. By the end of the century, for the country as a whole, a 15 to 20 per cent increase in precipitation is expected in winter, and a 10 to 30 per cent decrease in summer. The number of consecutive dry days may decrease by 10 to 15 per cent in winter, and increase by 15 to 25 per cent in summer, particularly in areas east of the Danube. The Hungarian trends analysed are in line with global climate change estimates and regional estimates for Central Europe. Overall, the climate change to be expected in Hungary is characterised by an increasing frequency of heat waves and a more extreme water regime (precipitation leading to aridification, droughts, flooding, and flooded soil). The evolution of extremes shows a marked spatial distribution to the detriment of Hungary's central, eastern and north-eastern regions in particular, which is a reminder of the significance of regional vulnerability studies." The foregoing is aptly illustrated in *Table 1*:

Table 1
Expected future evolution of temperature extremes in Hungary[18]

	Average value (days)	Projected change (days)	
	1961–1990	2021–2050	2071–2100
Frost days (Tmin < 0 °C)	93	–35	–54
Summer days (Tmax > 25 °C)	67	38	68
Hot days (Tmax > 30 °C)	14	34	65
Extremely hot days (Tmax > 35 °C)	0.3	12	34
Heat waves (Tavg > 25 °C)	4	30	59

Source: NCCS-2 (2013:14), Table 2.

[18] Hungarian averages of the changes based on PRECIS model simulations, using the A1B scenario. Values for the reference period (1961–1990) derived from the E-OBS database (named source: ELTE Department of Meteorology).

What do the insurance sector and customers need to prepare for? Primarily for a significant increase in average temperatures and unfavourable changes in precipitation, particularly in terms of distribution. Winters will be milder and more wet, while summers warmer and drier. This latter represents a serious risk to agriculture. Additionally, more severe and devastating storms and more supercells are to be expected, and as a side effect of this latter, more hailstorms and hail. An increase is to be expected in the severity and frequency of extreme weather events. These effects also present serious challenges to Hungarian insurers, primarily in connection with property insurance (including in particular home insurance), agricultural insurance, and certain types of liability insurance. Standard corporate responsibility and the professional analysis of long-term risks both require that insurers (and reinsurers) rethink and review their risk assessment models and activities as institutional investors by incorporating aspects of climate protection.

3.2. Climate change and the Hungarian insurance sector

3.2.1. Assessment of the current situation in Hungary: preparedness

Regarding today's Hungary and the preparedness of its insurance sector, the following can be reported:

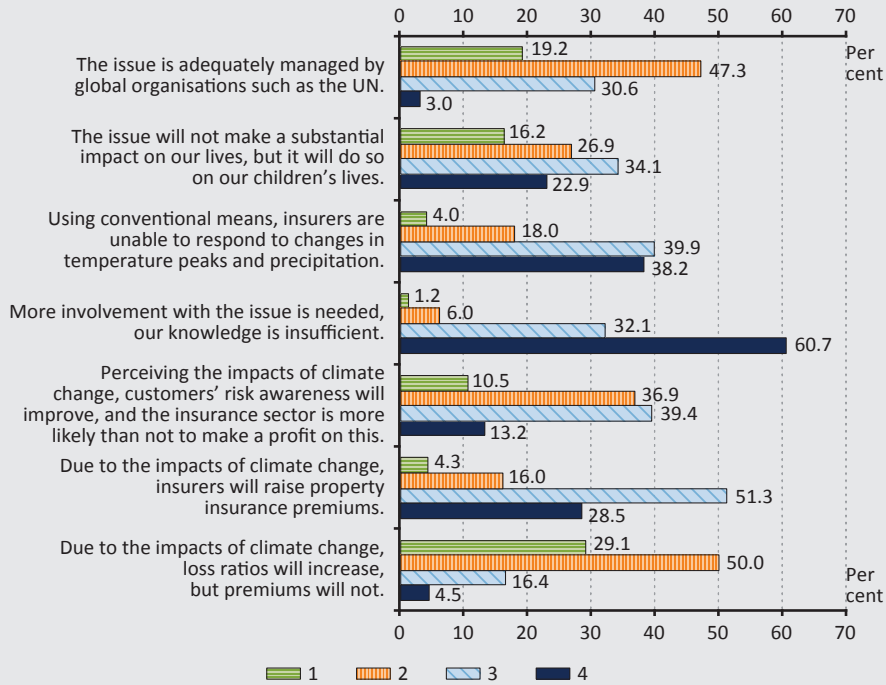
In connection with Project VAHAVA, Dr András Bárczay's paper has provided an excellent summary, in an international context, of the possible consequences and challenges of climate change for financial service providers, and insurers in particular (*Bárczay 2008*). On the provider side, in the 2000s Aegon, manager of the largest portfolio of home insurance, carried out GIS modelling and other in-depth research on the likely consequences of climate change. Selected results of that research have been published (*Vereczki 2010*). On the claims side, this learning process was significantly accelerated by the severe floods in the second half of the 2000s, and the resulting increase in claims payments. Research activities were set back by the discontinuation of the innovation contribution in the 2010s, which has also reduced providers' own resources for research. The organic learning process has become frustrated, and it is therefore not surprising that no major and recent publications are available on the exposure of the Hungarian insurance sector to climate change.

The extent to which our knowledge of the subject is limited is clearly indicated by the results of a recent primary research. In February 2016, approximately 400 respondents completed the survey questionnaire 'Future of the insurance sector in Hungary',[19] 61 per cent of whom completely agreed and another 32 per cent tended

[19] Between 26 and 29 February 2016, 413 respondents completed the questionnaire. Within the insurance sector, survey participants included managers working in various functional areas (31 per cent), insurance brokers (32 per cent), consultants working in the sector (17 per cent) and other professionals and supervisors (20 per cent).

to agree with the statement that lack of knowledge calls for more involvement with the issue of climate change (combined, 93 per cent of respondents felt they had insufficient knowledge about climate change) (*Figure 3*).

Figure 3
Do you agree with the following statements on climate change?



Note: 1 – completely disagree, 4 – completely agree.
Source: Pandurics (2016:23).

Apart from a lack of knowledge, the distribution of answers also indicates that to a significant extent, respondents consider the issue as a local problem outside the present, which will rather concern the life of the next generation (57 per cent tended to agree or agreed completely). At the same time, two-thirds of respondents thought that the problem was inadequately managed by global organisations (66.4 per cent tended to think this).

Responses indicate that in the insurance market, climate change is a phenomenon that actually carries increasing risk, which will exert upward pressure on property insurance premiums, leading more than three-quarters (79.8 per cent) of respondents to think that insurers will raise premiums due to the effects of climate change. Regarding the question on the impact of climate change on the

premium income of the insurance market in the next 5 years, a mere 25.9 per cent of respondents expect a negative impact. While possibly construed as conservative optimism,[20] this result highlights the need for the sector's greater efforts going forward in terms of providing affordable and available cover, and communicating changes in risk exposure.

In terms of the impacts on profitability, the percentages of respondents expecting a positive impact and a negative impact are practically the same (38.2 per cent and 39.7 per cent, respectively). This is another indication that there is an absence of professional consensus and adequate knowledge about the impact to be expected – on this point, not only the extent is questionable, but also the sign of the impact.

3.2.2. Measures and product development associated with climate change

Although the Hungarian insurance sector is inadequately prepared in an international comparison, it is also true that considerations relating to climate change are increasingly being incorporated into certain insurers' activities and product range.

In terms of *investments*, most investment service providers today offer 'green', 'climate' or 'sustainable' investment funds. These funds primarily seek to invest in the securities of companies the revenues of which are predominantly derived from the leverage of the business opportunities provided by global climate change (environmental management, energy efficiency, 'clean' and 'environmentally friendly' technologies, etc.), the use of alternative resources (renewable energy, water management, agricultural chemistry, etc.) and agricultural activities (biotechnology, animal farming, fish farming, agricultural technology, agricultural meteorology, etc.). Regarding the products, however, an approach of replication and imitation seems to be prevailing in the Hungarian market, essentially consisting in the fact that products that are labelled 'green' in other countries (or underlie such products) have already appeared, but their communication almost entirely lacks the element of adaptation to climate change.

In the field of *agricultural insurance*, the instrument of subsidies on agricultural insurance premiums was reintroduced in 2012 after an 'enforced rest' of 15 years, and currently provides a subsidy of up to 65 per cent on agricultural insurance plans tailored to specific crops. In 2015, the subsidy amounted to HUF 5.7 billion, and was granted to about 8,600 farmers.[21] However, the successful subsidy model and its communication rely exclusively on the security of farming, with a complete absence of climate change considerations and elements of possible adaptation.

[20] Precise percentages: highly negative 4.0 per cent, slightly negative 21.9 per cent, neutral 20.2 per cent, slightly positive 47.4 per cent, highly positive 6.5 per cent.
[21] http://www.biztositas.ma/4-milliard-novenybiztositasi-dijtamogatas-2016-ban

'*Pay-as-you-drive*' car insurance: while these products are being made available by an increasing number of providers in the Hungarian market (e.g. Safe-Line, Vemoco), expert literature has failed to highlight the green nature of the products, focusing on the innovative character and customer experience instead. Nevertheless, this product group can already be considered 'climate-conscious' in that it rewards responsible customers by incorporating appropriate incentives (discounts). Similarly, a new direction in product development may be taken towards the positive discrimination of customers in the field of covering 'green' property or shared movables. The exposure of *home insurance products* to climate change is undeniably high, but this is far from being obvious to customers today. Apart from increased transparency on risks (see German and Austrian maps and applications), the appropriate pricing of risks and the introduction of adequate incentives, initiatives on the required regulatory changes may also be important in this regard. Possible directions include adjustments to construction standards by taking account of climate hazards, the deliberate mitigation of flood risks (e.g. in the course of issuing construction permits in areas at risk), or incentives for investments to prevent natural disasters.

Mention should also be made of *professional liability insurance for construction and design* relating to the stock of buildings. The essence of this plan is that buildings are protected by the processes, materials and technologies used by designers and constructors against risks that could emerge as late as decades after construction, making this one of the areas where adaptation to climate change should start. In Hungary, such insurance follows the common rules for liability insurance, providing cover for the period during which the insurance is in effect. However, through limitations on reporting claims, Hungarian market practice makes this type of insurance virtually useless in many cases, since defects attributable to liability for design or construction rarely emerge in the first few years following construction. Unfortunately, regulations effective as of this year (*Építési Jog 2016*) requiring liability insurance on a mandatory basis also fail to solve this problem; indeed, disregarding elements of quality and consumer protection could lead to severe damage going forward. A meaningful solution could be provided by specifying reasonable liability insurance periods in respect of the design and construction of buildings, similarly to Germany (5 years) and France (10 years). This would presumably increase construction costs, while also improving the tolerance of buildings for meteorological risks, and therefore the stability of their value as well.

4. Summary

Based on the NCCS-2 discussion paper, the challenge of climate change is unquestionably a major risk in Hungary as well, which requires adequate responses. In turn, responses need good questions first. Given the shortfall observed regarding the Hungarian specificities of the insurance sector, we consider that the importance of the issue, good questions and responses, and the development of industry recommendations call for concerted action. In that spirit, it appears advisable to set up an 'inter-departmental' professional body comprising representatives of the Association of Hungarian Insurance Companies (MABISZ), the supervisory authority (MNB), the water authority and the expert and academic community, which could put forward recommendations on a 'climate change adaptation roadmap' for the Hungarian insurance sector in the broad sense, including customers, brokers and the supervisory authority. Since the core responsibilities of the insurance sector arguably include the promotion of prevention and adaptation activities carried out with a view to the management, transfer and mitigation of risk, Hungarian insurance companies may reasonably be expected to play an active role in minimising the negative impact of climate change on Hungary and Hungarian customers.

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