

## Article

# Adaptation to Climate Change and Insurance Mechanism: A Feasible Proposal Based on a Catastrophe Insurance Model for Taiwan

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### ABSTRACT

*In response to mitigating catastrophe risk resulting from climate change, insurance plays a crucial role in transferring and spreading risk. While little debate exists among scientists and evidences as to whether human activities are significantly causing the trend of increasing global temperatures which will lead to climate change, it is still impossible to predict the effect on climate caused by increasing concentrations of Green House Gases (as GHGs). This also leads to the uncertainty of economic losses due to extreme-weather-related events and increases the difficulties of modelling catastrophe risk to the insurance industry.*

*As the uncertainty of climate change risk will significantly affect the insurability of liability relating to tort litigation, it would be essential to discuss the appropriate insurance mechanism to distribute and reallocate catastrophe risk. With regard to liability insurance model mainly based on torts and environmental liability, it should consider not only liability regime for such damage (i.e., negligence, strict, and retroactive) but also the burden of proof regarding causal uncertainty. Therefore, appropriateness of liability insurance would rely on the efficiency of tort-based climate change litigations.*

*On the other hand, insurance mechanism based on compensation (e.g. compensation scheme and compulsory insurance) seems to provide with the direct*

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*financial protection for victims affected by climate change... Several developed insurance models relating to catastrophe risk (for instance, earthquake fund can be considered as an efficiency model for adaptation to climate change. In this work, the author would focus on the comparative study between liability insurance based on the emitter's liability and first-party insurance based on the compensation of the victims of climate change. Taking into account with current insurance schemes in Taiwan, this work intends to propose a viable insurance mechanism for adaptation to climate change.*

**Keywords:** *Climate Change, Catastrophe Insurance, Torts, Liability Insurance, Causation, Microinsurance, Environmental Liability*

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## I. INTRODUCTION

In response to mitigating catastrophe risk resulting from climate change, insurance plays a crucial role in transferring and spreading risk. While little debate exists among scientists and evidences as to whether human activities are significantly causing the trend of increasing global temperatures which will lead to climate change, it is still impossible to predict the effect on climate caused by increasing concentrations of greenhouse gases (as GHGs). This also leads to the uncertainty of economic losses due to extreme-weather-related events and increases the difficulties of modeling catastrophe risk to the insurance industry.

While any one of us might be harmed by almost anything, “we regulate only some, not all, of the risk that fills our world”<sup>1</sup> under modern risk regulation regimes. In order to make our life safer, risk regulation raises considerable challenges to governments.

To control and regulate risks, there should be in an effective and acceptable manner to choose the appropriate regulatory technique. From the viewpoint of the Market Failure (MF) hypothesis,<sup>2</sup> it has been observed that “regulatory regime content will reflect the inherent nature of each risk, and specifically the extent to which it is technically feasible for markets, including insurance, or the law of tort to operate as regulators of risk.”<sup>3</sup> Controlling and regulating risks may also involve “the adoption of strategies to minimize the production of risks or it may be concerned with mitigating the adverse effects of hazards”.<sup>4</sup> In order to mitigate risks such as traffic accident, environmental damage and catastrophes, the role of insurance and compensation schemes are becoming essential to risk regulation. As a result, issues concerning the role of insurance and compensation mechanisms are worth noting particularly in regard to the problems of moral hazard and adverse selection.<sup>5</sup>

This study first will briefly describe how climate change is having significant impact on the insurance industry. In Part II, it will focus on the concept of insurability of insurance coverage regarding natural disasters due to GHGs. As climate change is already affecting major types of insurance products, the willingness of insurers and affordability of insurance should be

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1. STEPHEN BREYER, *BREAKING THE VICIOUS CIRCLE: TOWARD EFFECTIVE RISK REGULATION* 7 (1993).

2. In this hypothesis, the government “will experience pressure to restrict its economic interventions to the minimal response necessary to correct market failure.” CRISTOPHER HOOD, HENRY ROTHSTEIN & ROBERT BALDWIN, *THE GOVERNMENT OF RISK: UNDERSTANDING RISK REGULATION REGIMES* 70 (2001).

3. *Id.* at 70.

4. ROBERT BALDWIN & MARTIN CAVE, *UNDERSTANDING REGULATION: THEORY, STRATEGY AND PRACTICE* 143-44 (1999).

5. *Id.* at 144.

addressed as well.

With regard to liability insurance, this paper will then reexamine the current tort laws in dealing with the emission of GHGs in Part III. Among these issues, uncertainty of the causal relationship has raised enormous challenge to the plaintiffs. It has been proposed by the scholars that the proportional liability rule may be employed to force the defendants to compensate the plaintiffs' losses in proportion to the way in which the defendant contributed to the risk. Due to the limitation of tort laws as an efficient mechanism for compensation, however, the model of public-private partnership<sup>6</sup> in compensation scheme and insurance to promote adaptation of catastrophe risk would be a better solution. In this regard, governments are expected to provide compensation for the victims and can be deemed as being the ultimate insurers for all societal risks. Taking into account the current regime of compensation schemes and natural disaster insurance system in Taiwan, this article will propose the feasible solutions concerning existing insurance models to mitigate climate change risk in Part IV.

## II. INSURABILITY OF CATASTROPHE RISK ARISING FROM CLIMATE CHANGE

As weather-related natural catastrophes resulting from climate change are expected to increase in frequency and severity, it is estimated that insured losses alone have "jumped from an annual 5 billion USD in the period between 1970 and 1989 to annual 27 billion over the last two decades."<sup>7</sup> It has become a priority for the global insurance industry to develop new strategies not only to facilitate adaptation to climate change but also to mitigate carbon emissions efficiently.

With regard to insurability of catastrophe risk,<sup>8</sup> it is essential to discuss possible insurance coverage and the types of pure risk. Three broad categories of pure risk may be classified as follows: (1) Personal Risk (such as illness, disability and death); (2) Property Risk (including direct loss and

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6. Public-private partnership (PPI) generally refers to arrangements between "the public and private sectors whereby some the services that fall under the responsibilities of the public sector are provided by the private sector, with clear agreement on shared objectives for delivery of public infrastructure and/or public services", The World Bank, *What are Public Private Partnerships*, PPP OVERVIEW,

<http://ppp.worldbank.org/public-private-partnership/overview/what-are-public-private-partnerships> (last visited Mar. 3, 2014). With regard to compensation scheme, there were many developed compensation scheme based on the partnership between the government and the private insurers.

7. Patrick Reichenmiller, Andreas Spiegel, David Bresch & Reto Schnarwiler, *Weathering Climate Change: Insurance Solutions for More Resilient Communities* 3 (2010), [http://media.swissre.com/documents/pub\\_climate\\_adaption\\_en.pdf](http://media.swissre.com/documents/pub_climate_adaption_en.pdf) (last visited Oct. 15, 2014).

8. For the definition of catastrophe risk, see American Academy of Actuaries Catastrophe Management Work Group, *Catastrophe Exposures and Insurance Industry Catastrophe Management Practices* 1 (2001), [http://www.actuary.org/pdf/casualty/catastrophe\\_061001.pdf](http://www.actuary.org/pdf/casualty/catastrophe_061001.pdf) (last visited Oct. 15, 2014).

indirect or consequential loss); and (3) Legal Risk (liability risk).<sup>9</sup>

A. *The Impact of Climate Change on Insurance Industry*

Due to heat-related stress and infectious diseases caused by global warming, higher increases in mortality and morbidity are expected. Several studies in the last decade already commented that “the climate change could expand the range and epidemic potential of malaria, dengue, encephalitis and schistosomiasis. ... Warmer, moister conditions not only facilitate the spread of mosquitoes, but also shorten the incubation period of malaria parasites and dengue virus, thereby enhancing their potential for spreading disease.”<sup>10</sup> Therefore, the severe consequences of personal risk including illness, disability and death, may significantly impede the solvency of life insurers.

With regard to property risk and legal risk mainly covered by non-life insurers, property insurance, liability insurance and D&O liability insurance (Directors and Officers) should also be affected by the extreme-weather events and uncertainty of litigation. For non-life insurers, extreme weather (such as hurricanes, floods, and wildfires) and sea-level rises have caused substantial impact on buildings, houses, factories, and facilities and led to business interruption. Following the increasing degree of urbanization and value exposed to natural hazards,<sup>11</sup> the level of economic losses due to weather-related events becomes a threat to non-life insurers’ capacity to manage catastrophe risk. For instance, the dramatic increase in hurricane’s frequency and intensity due to global warming has already caused significant damage to the buildings and business facilities situated in the Caribbean and the Gulf of Mexico. Besides this, it has been predicted that the increase in economic losses due to flooding caused by rising sea-levels will affect property losses.

B. *Insurability of Climate Change Risks*

It is common that social insurance systems and compensation schemes

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9. EMMETT J. VAUGHAN & THERESE VAUGHAN, FUNDAMENTALS OF RISK AND INSURANCE 7-8 (1999).

10. Andrew Peara & Evan Mills, *Global Climate Change and its Implications for Life Insurance and Health Organizations*, Lawrence Berkeley National Laboratory Report 5 (1999), <http://evanmills.lbl.gov/pubs/pdf/cc-and-life-health.pdf> (last visited Oct. 15, 2014).

11. It has been observed by Howard C. Kunreuther and Erwann O. Michel-Kerjan that two principal socioeconomic factors directly have impact on the level of economic losses, namely degree of urbanization and value at risk. With regard to the degree of urbanization, there are expected to be twenty-six cities with a population greater than 10 million by 2015. This would lead to the concentration of exposure and the severity of economic losses. In addition, the increase in the value insured exposed to natural hazard would be an essential socioeconomic factor to pose a challenge for insurers. Howard C. Kunreuther & Erwann O. Michel-Kerjan, *Climate Change, Insurability of Large-Scale Disasters, and the Emerging Liability Challenge*, 155 U. PA. L. REV. 1795, 1806 (2007).

may provide the victims with basic financial protections such as medical care, workers' compensation and social security benefits. Their limited benefits and purposes may not always be served for climate change, it should therefore rely on the commercial insurers to protect the insured against natural catastrophe risk. How will the insurance industry use appropriate strategies and risk management methodologies to tackle such a challenge? This would be linked to the insurability of catastrophe risk from climate change. Before we discuss the insurability concerning the willingness and affordability of insurance mechanism, it should address the current impacts of climate change on the insurance industry.

As Sean B. Hecht of the Executive Director of UCLA Environmental Law Center has noted, extreme weather impacts may cause possible outbreaks of respiratory and infectious diseases, such as malaria and Lyme disease.<sup>12</sup> Heat wave and extreme cold weather caused by climate change may also be associated with excessive deaths among children and the elderly.<sup>13</sup> It has been estimated and addressed that over 52,000 deaths were caused by the 2003 heat wave in Europe.<sup>14</sup> Due to increased carbon dioxide and higher temperatures, the worsened air quality may "increase the symptoms and mortality of sufferers of asthma, allergies, and other respiratory condition".<sup>15</sup> Life insurers may not be well prepared for the dramatic changes in mortality and morbidity relating to illness and death, and these extreme weather patterns could consequently increase underwriting risks of life insurers and, hence their financial solvency. Even though short-term life insurance products can be amended annually by life insurers, stricter underwriting standards and increased premiums will affect the availability and affordability of relative insurance products to protect people against climate change.

With regard to climate change impact on the non-life insurance industry, insurers have made much more effort to address this issue. By using state-of-the-art modeling techniques, a recent study published by the Association of British Insurers<sup>16</sup> has released several important findings on the financial impact on insured risk of inland floods in Great Britain, winter windstorms in the UK, and typhoons in China. In light of the impact of climate change, the average annual insured inland floods in Great Britain

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12. Sean B. Hecht, *Climate Change and the Transformation of Risk: Insurance Matters, Changing Climates: Adapting Law and Policy to a Transforming World*, 55 UCLA L. REV. 1559, 1575-76 (2008).

13. *Id.* at 1576.

14. *Id.* at 1577.

15. *Id.* at 1576.

16. ASSOCIATION OF BRITISH INSURERS, ABI RESEARCH PAPER NO. 19: THE FINANCIAL RISKS OF CLIMATE CHANGE: EXAMINING THE FINANCIAL IMPLICATIONS OF CLIMATE CHANGE USING CLIMATE MODELS AND INSURANCE CATASTROPHE RISK MODELS 3 (2009).

could rise by 14 % to £ 633 million assuming a global temperature rise of 4°C. With regard to windstorms in the UK, the average annual losses could rise by 25 % to £ 827 million assuming a 1.45° southward shift in storm tracks. Furthermore, the average annual insured losses caused by typhoons in China could rise by 32 % to £ 345 million assuming a global temperature rise of 4°C.<sup>17</sup> With these developing modeling techniques mentioned above, insurers may have the ability to predict the increasingly visible signs of climate change risk. Taking into account the uncertainty which mainly affects the insurability of risk, however, mass tort litigation concerning the emitters' liability (e.g., nuisance and negligence conduct) becomes the most controversial issue concerning climate change litigation and liability insurance. It was observed by Christina Ross, Evan Mills & Sean B. Hecht in 2007 that the relevant categories of liability insurance surrounding climate change impact include commercial general liability, product liability, environmental liability, professional liability (directors and officers liability insurance), political risk liability concerning new government policies, and personal and commercial vehicle liability.<sup>18</sup>

In defining the insurability of legal risk relating to climate change, certain basic requirements should be considered first as follows.

(1) Randomness Requirement (the materialization of the risk must be random, unintended and unexpected);

(2) Actuarial Estimation Requirement (Given a specified time period, and the scope of the losses, it must be possible to estimate the frequency and severity of risk);

(3) Causal Relationship Requirement (the cause of losses must be directly assignable and allocable; *i.e.* the party responsible for the resulting damage, injuries and economic loss);

(4) Legal Entity Requirement (the third party must be an identifiable legal entity under civil law).<sup>19</sup>

In examining basic requirements of insurability, the uncertainty of increasing tort litigations poses a challenge for insurers to estimate the frequency and severity of risk. Moreover, the causal relationships between the conducts of emitters and the enormous losses affected by extreme-weather events have raised considerable academic discussions and proposals.<sup>20</sup> In relation to the victims affected by extreme-weather events (e.g., hurricanes and typhoons), it is difficult to identify potential tortfeasors

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17. *Id.* at 3.

18. Christina Ross, Evan Mills & Sean B. Hecht, *Limiting Liability in the Greenhouse: Insurance Risk-Management Strategies in the Context of Global Climate Change*, 43(A) STAN. J. INT'L L. 251, 283-84 (2007).

19. JÜRGEN SPÜHLER, EMERGING RISKS: A CHALLENGE FOR LIABILITY UNDERWRITERS 33 (2003), [http://media.swissre.com/documents/emerging\\_risks\\_a\\_challenge\\_en.pdf](http://media.swissre.com/documents/emerging_risks_a_challenge_en.pdf) (last visited Oct. 15, 2014).

20. These will be discussed further in the next section of this work.



(usually large GHG emitters) and explore the extent to which these defendants could be held liable for the victims' damages.<sup>21</sup> One proposed theory, "Proportionally Liability", can be applied for tort-based climate change litigation to determine the amount of damages for which the emitters should be held liable.<sup>22</sup>

Increased climate change lawsuits based on torts in litigation costs and liability may cause substantial financial loss to the relevant industries (such as fossil fuel companies, the electric power industry, major automobile manufacturers<sup>23</sup> and even the insurance sector itself), and the directors and officers in these companies may be held liable for claims of breach of fiduciary duty if they fail to establish climate change risk management and to comply with the relevant disclosure rules.<sup>24</sup> These would consequently affect D& O liability insurance. In coping with increasing litigations, it is inevitable for liability insurers to pay enormous litigation costs for the insured, regardless of the magnitude of climate change claims.<sup>25</sup> Overall, it is essential to understand the insurability of climate change risk and limit the uncertainty of potential claims.<sup>26</sup> A lack of willingness to adapt and a lack of affordability in insurance coverage would in turn make insurers unable to adapt with the catastrophe risk.

The uncertainty of climate change risk will significantly affect the insurability of liability relating to tort litigation, and it is essential to discuss the appropriate insurance mechanism to distribute and reallocate catastrophe risk. With regard to liability insurance models (third-party insurance)<sup>27</sup> based mainly on torts and environmental liability, these models should consider not only liability regimes for such damage (i.e., negligence, strict, and retroactive) but also the burden of proof regarding causal uncertainty. Therefore, the appropriateness of liability insurance would rely on the efficiency of tort-based climate change litigations.

On the other hand, insurance mechanisms based on compensation (e.g. compensation scheme and compulsory insurance) seem to adhere with direct financial protections for victims affected by climate change. However, this

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21. David A. Grossman, *Warming up to A Not-So-Radical Idea: Tort-based Climate Change Litigation*, 28 COLUM. J. ENVTL. L. 1, 22-33 (2003).

22. Kunreuther & Michel-Kerjan, *supra* note 11, at 1833-34.

23. Grossman, *supra* note 21, at 28-31.

24. Mark Latham, *Environmental Liabilities and the Federal Securities Laws: A Proposal for Improved Disclosure of Climate Change-related Risks*, 39 ENVTL. L. 647, 677-98 (2009).

25. Hecht, *supra* note 12, at 1578-79.

26. Hecht, *supra* note 12, at 1582-83.

27. Liability insurance policy is purchased by the insured (first party) from an insurers (second party) for protection against another party's claims (third party). Therefore, liability insurance also refers to third-party insurance. In contrast, if an insurance policy is paid by insured (first party) to provide coverage in the event of an accident, injury or loss, this compensatory insurance may refer to first-party insurance.

would lead to another drawback concerning the deterrence and mitigation of GHGs particular in moral hazard. In general, the compensation model could be divided into two subgroups by the operation of such a system. These will depend on whether state-administered or private insurance mechanisms are implemented. If a compensation scheme or public catastrophe fund was mainly conducted by governments,<sup>28</sup> it would raise serious concerns about competence and abilities for risk management. In addition to commercial insurance products, several developed insurance (first-party insurance) models relating to catastrophe risk (for instance, an earthquake fund) would also be considered as an efficient model for adaptation to climate change. With regard to any public funds, the primary obstacle for this model would be financial resources. Taking account of the current governmental financial conditions, it is questionable for most governments to prepare sufficient funds to compensate the victims of climate change and other catastrophes.<sup>29</sup> Because the primary purpose of this work is to analyze insurance mechanism, the following discussion will focus on a comparative study between liability insurance model based on the emitter's liability and catastrophe insurance model based on the compensation of the victims of climate change.

### III. LIABILITY INSURANCE MODEL FOR ADAPTATION TO CLIMATE CHANGE AND THE LIMITATION OF TORT?

With regard to liability insurance models, current tort theories and relevant tort litigations would influence the appropriateness of liability insurance in adaptation to climate change. "Scientific consensus has established with significant confidence a link between GHG and man-made global warming",<sup>30</sup> stated the US Supreme Court's decision in *Massachusetts v. Environmental Protection Agency*,<sup>31</sup> which further proved a causal link between GHG and global warming. Consequently, this decision could be applied by future plaintiffs as favorable proof in climate change tort litigation.<sup>32</sup> In reality, however, climate change victims seeking compensation would face several obstacles such as causal uncertainty, identification of the

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28. BALDWIN & CAVE, *supra* note 4, at 54.

29. To determine the choice between private insurance and public compensation, See Gerhard Wagner, *(Un)insurability and the Choice between Market Insurance and Public Compensation Systems*, 22 TORT & INS. L. 87, 87-88 (2007).

30. Gary Stix, *A Climate Repair Manual*, 295 SCI. AM. 46, 46 (2006) (it has been remark by Gary Stix in Scientific American, "Present levels of carbon dioxide-nearing 400 parts per million (ppm) in the earth's atmosphere-are higher than they have been at any time in the past 650,000 years"), cited from Daniel J. Grimm, *Global Warming and Market Share Liability: A Proposed Model for Allocating Tort Damages Among CO<sub>2</sub> Producers*, 32 COLUM. J. ENVTL. L. 209, 212 (2007).

31. *Massachusetts v. Environmental Protection Agency*, 549 U.S. 497 (2007).

32. See Grimm, *supra* note 30, at 215.

particular responsible defendants,<sup>33</sup> and the amount of compensation due them. In relation to environmental liability and climate change, it is also difficult to choose an appropriate rule between negligence and strict liability<sup>34</sup> to control and limit the emitters' activities in deciding an optimal liability rule. Among these issues, the development of theories of causation including market share liability and proportional liability becomes a vital requirement to define whether the emitters should be liable for damages influenced by climate change.

When choosing an appropriate insurance model with liability rules, the current obstacles we may face in tort litigation should be clearly understood. With respect to these obstacles, there are two controversial elements regarding retroactive liability and causal uncertainty proposed by Professor Michael Faure<sup>35</sup> that are worth exploring in order to discover possible solutions. In addition, it is reasonable to assume that the issue relating to causation will lead to another legal dispute which include the identification of tortfeasors and determination of the amount of compensation.<sup>36</sup>

#### A. *Retroactive Liability*

In light of environmental liability, retroactive liability rules have raised considerable doubts that are opposed by some academic opinions based on their functions of deterrence.<sup>37</sup> While damages in these instances might have occurred 20 or even 30 years ago, the main purpose of retroactive liability would seek to focus on compensation for the plaintiffs, rather than being preventative in nature or seeking to control the defendants' future activities. It is arguable that the defendants may not be aware of the hazards caused by their activities even when they were complying with the standards and relevant environmental regulations in the past.<sup>38</sup> Taking into account the similarity to climate change-based liability, it is also doubtful that the current emitters should be held liable for their past activities<sup>39</sup> even though some

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33. *Id.* at 216-17.

34. For discussion between negligence rule and strict liability, *see generally*, JAMES BOYD ET AL., DETERRENCE, INSURABILITY, AND COMPENSATION IN ENVIRONMENTAL LIABILITY: FUTURE DEVELOPMENTS IN THE EUROPEAN UNION 19-37 (2003).

35. Michael G. Faure, *Insurability of Damage Caused by Climate Change: A Commentary*, 155 U. PA. L. REV. 1875, 1877-88 (2007).

36. Grossman, *supra* note 21, at 10.

37. Faure, *supra* note 35, at 1878.

38. *Id.* at 1878.

39. IWORKING GROUP I OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE. A REPORT OF WORKING GROUP I OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, SUMMARY FOR POLICYMAKERS 2 (2007), *available at* <http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf> (according to IPCC Fourth Assessment Report, it is found that "the annual carbon dioxide concentration growth rate was larger during the last 10 years (1995-2005), than it has been since the beginning of continuous direct

emitters carried out their business in recent years. From the viewpoint of deterrence, it is questionable that retroactive liability may serve for this purpose. It has been argued that retroactive liability may weaken the incentive to take precautions against future environmental costs.<sup>40</sup> In other words, the function of retroactive liability may tend to serve for loss distribution and compensation rather than deterrence of defendants' future behavioral.<sup>41</sup> Other arguments would also be involved with the foreseeability of the tortfeasors to justify an action in tort. As the defendants' duty are usually defined by his reasonable foresight and knowledge, potential climate change defendants will argue whether the precise time the defendants would have been foreseeable to create a risk of damage.<sup>42</sup>

#### B. *Causal Uncertainty: Market Share Liability and Proportional Liability*

Although scientific studies have provided a recognized basis for a general causal link between climate change and GHG caused by human activities, they may raise considerable doubts regarding plaintiffs' adequate proof of specific causation.<sup>43</sup> Even with decision such as *Massachusetts v. Environmental Protection Agency*<sup>44</sup> mentioned above, further questions remain unanswered in order to prove the amount of potential defendants could be liable for. As a result, scholars have proposed two possible theories to establish the causal link between the damage and emitters' activities, namely proportional liability<sup>45</sup> and market share liability.<sup>46</sup>

Under the theory of proportional liability concerning climate change, Dr. Myles Allen, head of the Climate Dynamics group at the University of Oxford's Atmospheric, Oceanic and Planetary Physics Department, proposed that compensation based on a form of proportional liability could depend on the increased risk of natural disaster caused by GHGs.<sup>47</sup> If scientific evidence shows that the climate change caused by GHG emissions has increased the frequency of typhoons in the Pacific by 50%, the defendants (emitters) would be held liable for 50% of the plaintiff's losses.<sup>48</sup> This

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atmospheric measurements (1960-2005)").

40. James Boyd & Howard Kunreuther, *Retroactive Liability or the Public Purse?*, 11(1) J. REG. ECON. 79, 80 (1997), cited from Faure, *supra* note 35, at 1878.

41. Faure, *supra* note 35, at 1879-80.

42. This would also lead to the argument of the precise time when the emitters would already have been liable for their activities. Faure, *supra* note 35, at 1879. From a different perspective, see also Grossman, *supra* note 11, at 48.

43. Grossman, *supra* note 21, at 23.

44. *Massachusetts*, 549 U.S. 497 (2007).

45. See generally Grossman, *supra* note 21, at 28-31.

46. See Grimm, *supra* note 30, at 211.

47. Myles Allen, *Liability for Climate Change*, 421 NATURE 891, 891-92 (2003), cited from Kunreuther & Michel-Kerjan, *supra* note 11, at 1833.

48. Kunreuther & Michel-Kerjan, *supra* note 11, at 1834.

would ease the tension caused by the “but-for” test with the “all-or-nothing” rule and would force the defendants to compensate the plaintiffs’ losses proportionally.<sup>49</sup> Although the proportional liability rule may seem to be a feasible solution for the plaintiffs, several practical difficulties have been identified such as determining the appropriate amount in response to the increased risk of catastrophe, and deciding who the responsible emitters<sup>50</sup> is.

Because the identification of tortfeasors in climate change based torts litigation would be difficult for the plaintiffs, it is worth noting the similarity of such features in harms caused by fungible products. In light of fungible products, market share liability was applied for Diethylstilbestrol (DES, the miscarriage prevention drug) in *Sindell v. Abbot Laboratories*.<sup>51</sup> This approach allocates liability among market participants according to their relative shares in the national product market. By applying market share liability to climate change, one should be aware of significant differences between DES and climate change. It has been observed that “the entirety of a plaintiff’s injuries will not possibly have been caused only by those firms in the emissions market”<sup>52</sup> but have also been caused by other natural perils while “many market share liability cases dealt with situations where the entirety of the plaintiff’s injury was caused by the defendants.”<sup>53</sup> The accuracy and the scale of the emissions market regarding a proportional amount would impede the plaintiffs’ recovery on a global basis.<sup>54</sup>

Although these arguments with their possible proposals may prove the necessity of torts litigation in favor of the plaintiffs, they would not be qualified as efficient approaches for compensating the victims affected by climate change. Even with the proposed theory of market share liability which might facilitate the plaintiffs in seeking proportional compensation, the cost regarding the proof of market share and the appropriate proportion would be enormous in these litigations. As a result, it should be noted that the uncertainty and litigation costs involved would impede the function of compensation that these proposals would be applied for.

In the context of liability insurance, the insurability of retroactive liability would be problematic. If insurers and the insureds (emitters) are not aware of this issue, it would endanger the financial solvency of insurers as inadequate for loss reserve<sup>55</sup> which is usually reserved for future losses. Furthermore, the theories of proportional liability and market share liability still pose significant obstacles in the present, liability insurance covering

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49. Faure, *supra* note 35, at 1882.

50. Kunreuther & Michel-Kerjan, *supra* note 11, at 1835.

51. *Sindell v. Abbott Laboratories*, 607 P. 2d 924, 936 (Cal. 1980).

52. Grimm, *supra* note 30, at 227.

53. *Id.* at 226.

54. *Id.* at 225-26.

55. Faure, *supra* note 35, 1880-81.

emitters' activities would still leave uncertainties for setting insurance premiums and designing insurance contracts.

C. *Tortious Liability and Liability Insurance: Lessons and Obstacles in Taiwan*

In terms of compulsory insurance models developed in Taiwan, there were two insurance mechanisms based on the public-private relationship, namely Compulsory Automobile Liability Insurance (CALI)<sup>56</sup> and Taiwan Residential Earthquake Insurance Fund (TREIF).<sup>57</sup> With regard to CALI system in Taiwan, it provides the traffic victims with limited amount of compensation regardless of whether the injuring party is at fault. Although it may connect with the tortious liability of the injuring party in accordance with Article 191-2 of Taiwan Civil Code, the CALI is based on the principal of no-fault liability to extend the protection for the traffic victims. This developed insurance model is worthy analyzing and could be used to identify the possible obstacles in developing liability insurance mechanism for climate change.

While the principal of tortious liability regarding automobile accidents was amended from negligence principal to strict liability in article 191-2 of the Taiwan Civil Code, the CALI Act makes a step forward to provide with basic insurance benefit for the traffic victims under no-fault compensation in accordance with Article 7 of the CALI Act.<sup>58</sup> Although the traffic victims are not required to prove that the defendants fail to fulfill the duty of care or even regardless of whether the defendant is at fault, they still need to show that there was a causal connection between his injury and the tortfeasor's conduct. In a traffic accident case, it is easy for victims to prove the causation and identify the defendants. When it comes to climate-related harms, the main obstacle concerning causation still remains unsettled and

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56. Taiwan Compulsory Automobile Liability Insurance is developed to provide the traffic victims with basic protection. The Compulsory Automobile Liability Insurance Act became effective on January 1, 1988. *Origin of Compulsory Automobile Liability Insurance*, COMPULSORY AUTO. LIABILITY INS., available at <http://www.cali.org.tw/en/about.aspx> (last visited Sept. 8, 2013) ("the legislative history of the Compulsory Automobile Liability Insurance").

57. In order to build up and strengthen the capacity to deal with earthquake risk, the Taiwan Residential Earthquake Insurance Fund was established on November 20, 2001. *Preface of Taiwan Residential Earthquake Insurance Fund*, TAIWAN RESIDENTIAL EARTHQUAKE INS. FUND, available at [http://www.treif.org.tw/e\\_contents/A\\_aboutTREIF/A1.aspx](http://www.treif.org.tw/e_contents/A_aboutTREIF/A1.aspx) (last visited Sept. 8, 2013) ("for information regarding Taiwan Residential Earthquake Insurance Fund").

58. CHIANGCHIH CHICHE TZAREN BAOSHIAN FA art. 7 (強制汽車責任保險法) [Compulsory Automobile Liability Insurance] (amended at May 19, 2010), available at <http://law.tii.org.tw/Eng/FLAWDAT0202.asp?No=1A0030116&lsid=FL037251&hasChar=False&btnType=0&rlType=> (last visited Sept. 8, 2013) ("....., regardless of whether the injury party is at fault, a claimant may claim insurance benefits from an insurer or compensation from the Motor Vehicle Accident Compensation Fund.").

questionable.<sup>59</sup> This also means that the climate-related victims have to demonstrate the causal link and to identify the responsible remitters before their claims for liability insurance benefit. Without the significant reform on the current tort law,<sup>60</sup> these limitations concerning causation will hinder the viability of liability insurance model. Even taking into account with the theory of market share liability, it still is difficult to determine the particular emitters due to the extraordinary numerosity of emitters on a global scale. In addition to the complexity of burden of proof on causation, enormous litigation costs would still pose severe challenge not only to climate-related victims but also to the defendants and their liability insurers. As a result of the debates related to tort law, liability insurance model would not be viable and may not be efficient to encounter the increasing climate-related harms at present.

#### IV. NATURAL DISASTER INSURANCE MODEL: A VIABLE PROPOSAL OF INSURANCE MECHANISM

While liability insurance approach mainly depends on the certainty of the emitters' tortious liabilities, it is doubtful that we may provide the appropriate compensation for the victims affected by extreme weather events. Even with the theoretical proposals regarding proportional liability and market share liability, the classical tort doctrines concerning causation may still remain difficult to deal with the complexity of climate change issues. While the development of tort theories and liability insurance-based models may be impractical, they would lead to a consideration of the appropriateness of catastrophe insurance based on compensation of the victims of climate change.<sup>61</sup>

In terms of catastrophe insurance model, climate change victims may receive their basic financial protection from catastrophe insurers without any claims against the emitters. The major barrier from tort law would disappear and the causal connection between the emitter's activity and the climate-related victims would not be a controversial issue for those who seek for compensation after the extreme weather event. If the framework of catastrophe insurance model has been well designed and established, the insurance premiums collected from the major emitters will not only prepare for the future losses but also will enhance to internalize the external cost of

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59. See generally Douglas A. Kysar, *What Climate Change Can Do about Tort Law?*, 41 ENVTL. L. 1, 29-42 (2011).

60. See *Id.* at 63 ("even with the other proposed solutions e.g., market share liability and proportional liability, there still are debates on these proposals.").

61. While the environmental liability may cause substantial litigation costs for the plaintiffs, another approach based on the protection of the victims has been implemented in the Netherland. For further discussion see BOYD ET AL., *supra* note 34, at 217-25.

GHGs.

As a result, this work will turn to the alternative solution based on the catastrophe insurance model and will analyze the viability of this model. Before exploring and proposing a viable approach, the main challenges for the catastrophe insurance model mentioned above should also be kept in mind.

A. *Developed Catastrophe Insurance Models and Their Characteristics*

In dealing with catastrophe risk and the limitation on private insurers' capacities, natural disaster insurance based on public-private relationship can be found in many countries and areas (e.g. France, Japan, New Zealand, Spain, Turkey, USA, California, Florida, and Hawaii).<sup>62</sup> Based on public-private partnerships, it is found that the government can be deemed as the most appropriate insurer of last resort to extend the limited capital and capacity of private insurers. Furthermore, the government with its legitimacy is able to enforce risk mitigation measures, to provide compulsory insurance coverage for catastrophes in order to spread risk throughout the entire society.<sup>63</sup> For example, the Earthquake Commission (as EQC)<sup>64</sup> was established in New Zealand to provide earthquake and other relevant natural disaster (e.g., natural landslip, volcanic eruption, hydrothermal activities, and tsunami) coverage for purchasers of fire insurance. Under such a quasi-compulsory insurance scheme, EQC mainly covers dwellings (self-contained premises used as home, including apartments), most personal property but excluding some types (e.g., motor vehicle and art) the land immediately around the dwelling, main access ways, and retaining walls, with certain limits.<sup>65</sup> When an insured purchases a fire insurance policy for his home and personal belongings, a disaster insurance premium from the EQC insurance is charged in accordance with Article 18 to 20 of the Earthquake Commission Act 1993.<sup>66</sup> In this model, the EQC with its Natural

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62. See Organization for Economic Co-operation and Development, *Environmental Risks and Insurance a Comparative Analysis of the Role of Insurance in the Management of Environment-related Risks* 67-69 (2003), available at <http://browse.oecdbookshop.org/oecd/pdfs/product/2103091e.pdf> (last visited Oct. 15, 2013).

63. See *Id.* at 70.

64. For information about the Earthquake Commission in New Zealand, see About EQC, EARTHQUAKE COMMISSION (N. Z.), <http://www.eqc.govt.nz/about-eqc> (last visited Sept. 8, 2013).

65. For information about the EQC insurance, See Earthquake Commission (N. Z.), *Householder's Guide to EQCover*, 13 (Sept. 16, 2013), [http://www.eqc.govt.nz/sites/public\\_files/EQC\\_HouseHoldersGuide\\_WEB.pdf](http://www.eqc.govt.nz/sites/public_files/EQC_HouseHoldersGuide_WEB.pdf) (last visited Oct. 15, 2013).

66. Earthquake Commission Act 1993 No. 84, as at 1 July 2013 (N.Z.), available at [http://legislation.govt.nz/act/public/1993/0084/latest/DLM305968.html?search=ts\\_act%40bill%40regulation%40deemedreg\\_Earthquake+Commission+Act+1993\\_resel\\_25\\_h&p=1](http://legislation.govt.nz/act/public/1993/0084/latest/DLM305968.html?search=ts_act%40bill%40regulation%40deemedreg_Earthquake+Commission+Act+1993_resel_25_h&p=1) (last visited Sept. 16, 2013).



Disaster Fund backed by government guarantee is New Zealand's primary provider of natural disaster insurance to residential property owners.

Because several insurance models based on public-private partnerships have been implemented for long periods, it would be a feasible and workable solution to extend the current coverage to extreme-weather events. In this regard, serious doubts might be raised as to whether this insurance model should be compulsory or not, and it would also be problematic to decide who should be responsible for insurance premiums. In New Zealand, EQC insurance is compulsory only when the owner of the dwelling purchases fire insurance. The liberty of the owners of the dwellings would remain if they did not purchase fire insurance. Furthermore, the cost of coverage may impede the distribution of catastrophe risk and the protection of victims in poverty. As a result, the burden of compensation would be left to the government by way of social security benefits.

B. *Possible Obstacles and Drawbacks Relating to Natural Disaster Insurance Model*

In terms of insurance model based on compensation, three drawbacks usually may arise in the followings. Firstly, moral hazards caused from the insured should be controllable in a manner.<sup>67</sup> When potential victims in hazardous areas (e.g. the buildings along the coastline) get coverage, this would consequently decrease an incentive to mitigate the loss of life and property damage in these areas.<sup>68</sup> Secondly, the inefficiency of compulsory insurance should also be considered. Given mandatory insurance coverage with monopolistic premiums, this would not only reduce the incentive for the insurer to take appropriate measurements to compete for low costs but also might influence the competence of the insurers in risk management. Thirdly, fixed and flat premiums might increase the adverse effects associated with the cross-subsidization and distortion of risk discrimination and allocation. Compulsory insurance could involve constitutional issues regarding equity among different classes of customers.<sup>69</sup> As a result,

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67. BOYD ET AL., *supra* note 34, at 185.

68. Wagner, *supra* note 29, at 95-98 (it is common to see moral hazard both in third-party insurance and first-party insurance. This would decline the level of care with the transfer of the risk to the insurer.).

69. For example, gender-discrimination which is often implied as a risk classification parameter by an insurer would raise serious concerns regarding equity and gender. From 21<sup>st</sup> Dec. 2012, European insurers will not be allowed to use gender as a factor in risk discrimination following a ruling by the European Court of Justice. See Press Release, Sex Discrimination in Insurance Contracts: Statement by European Commission Vice-President Viviane Reding, the EU's Justice Commissioner, on the European Court of Justice's ruling in the Test-Achats case, European Commission, *available at* <http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/11/123&guiLanguage=en> (last visited Sept. 8, 2013).

compulsory insurance schemes with discriminatory treatment of the insured would be deemed as violations of equity among citizens. However, fixed and flat premiums without risk classification consequently would lead to cross-subsidization of the high-risk insured through the contributions of the low-risk insured. Hence, it would increase the severity of moral hazard in this system and the inefficiency of risk allocation.

When compared with the uncertainty of third-party insurance based on torts, compulsory catastrophe insurance may seem to be a more viable and feasible solution. However, moral hazard, inefficiency of insurance markets and possible risk discrimination could also be significant obstacles in this approach. Taking into account the catastrophic effect on the insured, it may not have substantial effects on the insured's behavior in terms of moral hazard, especially with limited compensation. Furthermore, this can be mitigated by way of insurance coverage e.g., deductibles, exclusions and co-insurance.<sup>70</sup> As for the competition of the insurance market, this would leave room for the government to supervise private insurers with flexible regulations concerning premiums and coverage.<sup>71</sup> To avoid cross-subsidaries among different risk classes and fairness of contribution regarding risk premium, it is suggested that the appropriate risk classification that might reduce the incentive to live in catastrophic-prone areas should be designed in this scheme. If these factors only are based on the severity and frequency of the risk insured, they may not be challenged on their principle of equity among citizens.

In general, these obstacles are "moral hazard" and "risk discrimination". When the insured should be partially responsible for the loss with limited insurance in the extreme weather events benefits, the existence of moral hazard<sup>72</sup> could be minimized. As for risk discrimination, the appropriate risk classification should be developed as well.

Even with solutions to tackle these problems associated with catastrophe insurance models, it is still questionable to determine the beneficiaries who are entitled to receive insurance payment with limited financial resource and how to decide the emitters who are responsible for insurance premium. With regard to the beneficiaries, it is suggested that the catastrophe insurance model for climate change should provide those in poverty with basic life insurance benefits. For those who live in hazardous areas (e.g., coastal, mountain area), they are exposed to the threat of typhoons, heavy rainfall, flood and landslide. Most of those who live in these areas are in poverty and

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70. Wagner, *supra* note 29, at 108.

71. ROTHSTEIN & BALDWIN, *supra* note 2, at 22 ("it should also be careful in "regulatory rent" when the private insurers capture or influence the regulator.").

72. HAROLD D. SKIPPER & W. JEAN KWON, RISK MANAGEMENT AND INSURANCE: PERSPECTIVES IN A GLOBAL ECONOMY 483 (2007).

lack financial capacity to cope with climate-related risks. They are also unable to purchase insurance policies from the private insurance market. Therefore, it is suggested that the protection of people in poverty should be the priority in the proposed catastrophe insurance model.

Although the same issue regarding the identification of the emitters might still arise in the catastrophe insurance model, the model based on compensation might be more viable than that based on the torts with the causation complexities which have been addressed above.<sup>73</sup> Based on polluter pays principal, major emitters should be responsible for insurance premium of catastrophe insurance scheme. This will provide a basic compensation for those in poverty. In addition, insurance premium can be designed to offer incentives and financial motivation to major emitters. Catastrophe insurance model can be combined with the use of incentives to minimize emissions by allowing premium reductions to emitters taking GHG reducing measure. We should bear in mind that the problems associated with climate change liability insurance might be replicated in determining the appropriate level of premium shared by the major emitters. In contrast to tortious liability, it can be calculated and decided on the current emitters rather than the historical evidences. The main purpose of catastrophe insurance model is to collect appropriate amount of premium to provide with basic financial protection for the future generation.

### C. *Developing a Feasible Catastrophe Insurance Scheme in Taiwan Based on the Current Developed Compensation Schemes*

Before we consider the possible and viable insurance mechanism, it is worth introducing the current insurance framework in Taiwan. To encounter the financial impact caused by climate-related events in Taiwan, these can be categorized into two kinds of insurance systems, namely social insurance systems and private insurance market. With regard to social insurance systems, National Health Insurance (as NHI)<sup>74</sup> and other compensation schemes (such as Labor Insurance)<sup>75</sup> will provide the victims with the basic financial compensation including medical costs and social insurance benefits. Although the main purpose of these mechanisms is not to adapt climate change risk, it still can be deemed as the most fundamental social security system to mitigate the financial losses caused by extreme weather

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73. Melissa Farris, *Compensation Climate Change Victims: The Climate Change Fund as an Alternative to Tort Litigation*, 2(2) SEA GRANT L. & POL'Y J. 49, 60 (2009-2010).

74. *Universal Health Coverage in Taiwan*, BUREAU OF NAT. HEALTH INS. (TAIWAN), [http://www.nhi.gov.tw/Resource/webdata/21717\\_1\\_20120808UniversalHealthCoverage.pdf](http://www.nhi.gov.tw/Resource/webdata/21717_1_20120808UniversalHealthCoverage.pdf).

75. *Introduction of Labor Insurance in Taiwan*, BUREAU OF LABOR INS. (TAIWAN), <http://www.bli.gov.tw/en/sub.aspx?a=w7P%2ftqS4BkI%3d>.

events. In terms of private insurance market, the life insurance industry will provide with insurance products for losses relating to sickness, injury, disable and death. In case of loss of property, the property insurance industry offers insurance policies directly against natural disasters.

In considering the current insurance mechanisms in Taiwan, financial impact caused by injury, disable and death are definitely should be the priority of catastrophe insurance model. Because the basic medical costs have been already covered by Taiwan NHI, we should then consider the possible types of insurance to insure personal injury, disable and death. While social insurance schemes (e.g., labor insurance) have provided the basic benefits for those insureds<sup>76</sup> and their survivors,<sup>77</sup> the priority of catastrophe insurance should be to protect those who are the most vulnerable to climate change. In practice, microinsurance for low-income people against specific perils has been developed in many countries.<sup>78</sup> While the governmental social security policy is not based on the general principles of insurance such as premiums relating to the risk, microinsurance redistributed by a variety of different entities could provide “risk-pooling instruments for the protection for low-income households”.<sup>79</sup> The main purpose of microinsurance is to cover a variety of different risks including life insurance and property insurance for low-income people who may not be covered by other private insurance or social security schemes.<sup>80</sup> To encounter with the climate change risks, microinsurance for people in poverty is essential to extend their financial capacity in an affordable and viable approach. Among the different funding of microinsurance, hybrid microinsurance<sup>81</sup> partially

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76. In case of personal injury in Taiwan Labor Insurance, the insureds are entitled to receive injury benefits, permanent disability benefits and occupational accident medical benefits. *Insurance Benefits*, BUREAU OF LABOR INS. (TAIWAN), <http://www.bli.gov.tw/en/sub.aspx?a=cHVoa5l2xNw%3d> (last visited Sept. 8, 2013).

77. *Introduction to Survivor Benefit*, BUREAU OF LABOR INS. (TAIWAN), <http://www.bli.gov.tw/en/sub.aspx?a=AlAOoGmt%2bOw%3d> (last visited Sept. 8, 2013).

78. The Consultative Group to Assist the Poor (CGAP), *Microinsurance: A Risk Management Strategy, Helping to improve Donor Effectiveness in Microfinance*, DONOR BRIEF NO. 16 (2003), <http://www.cgap.org/sites/default/files/CGAP-Donor-Brief-Microinsurance-A-Risk-Management-Strategy-Dec-2003.pdf>. See generally International Association of Insurance Supervisors and CGAP Working Group on Microinsurance, *Issues in Regulation and Supervision of Microinsurance* 10-14 (2007), [http://www.a2ii.org/fileadmin/data\\_storage/documents/internal\\_documents/Issues\\_Paper\\_in\\_regulation\\_and\\_supervision\\_of\\_microinsurance\\_June\\_2007.pdf](http://www.a2ii.org/fileadmin/data_storage/documents/internal_documents/Issues_Paper_in_regulation_and_supervision_of_microinsurance_June_2007.pdf).

79. International Association of Insurance Supervisors and CGAP Working Group on Microinsurance, *supra* note 78, at 10.

80. International Association of Insurance Supervisors and CGAP Working Group on Microinsurance, *supra* note 78, at 10-11.

81. International Association of Insurance Supervisors and CGAP Working Group on Microinsurance, *supra* note 78, at 15 (“the funding of microinsurance runs along a continuum where premiums may be fully paid by the policyholders (privately funded) or they may be partially or fully paid by the State or other components of society”. These different types of funding of microinsurance are Privately Funded, Hybrid, and Publicity funded social insurance schemes.).

funded by social security schemes or particular funds could be used as the prototype for the development of catastrophe insurance model for climate change. As a result, specific emitters can be required to pay the premiums either partially or wholly for this microinsurance covering climate related risks and losses. This will not only provide the basic compensation for low-income people who live in highly risk-exposed areas but also internalize the GHGs-related cost caused by the major emitters' activities. Although it is still controversial to determine the major emitters and the appropriate amount of premium, it is still viable to design a hybrid microinsurance based on the mitigation in GHGs. In other words, insurance premium should be collected and calculated on the current major emitters and possible financial incentives to allow premium reductions to those emitters taking reducing GHG measures.

#### IV. CONCLUDING OBSERVATIONS

In a context of societal risk management, government has a crucial role to influence health, safety and environmental outcomes.<sup>82</sup> In countless examples of catastrophes from natural hazards (earthquakes, tsunamis, hurricanes, typhoons, floods etc...),<sup>83</sup> governments are expected to provide compensation to the victims and can be deemed as being the ultimate insurers for all societal risks.<sup>84</sup> Human-made catastrophes, including terrorism, environmental risks (climate change, genetic engineering, and nuclear-generated electrical energy), and product risks, are also expected to be prevented or mitigated by the governmental efforts.

In this work, the author would like to propose a feasible solution based on current natural disaster insurance models in some countries.<sup>85</sup> Although catastrophic risk caused by climate change may not be fully transferred and distributed to the society, compulsory insurance scheme based on public-private partnerships will not only extend the capacity of private insurers but also help the government to efficiently provide the victims with basic financial protections in these extreme-weather events. When the people in poverty are the most vulnerable group to the extreme weather events,

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82. See generally W. KIP VISCUSI, *FATAL TRADEOFFS: PUBLIC AND PRIVATE RESPONSIBILITIES FOR RISK* 285 (1992), cited from Skipper & Kwon, *supra* note 72, at 86.

83. 921 Earthquake in Taiwan in 1999, Indian Ocean tsunami, hurricane Katrina in 2005 and recent 88 Flood in southern Taiwan.

84. SKIPPER & KWON, *supra* note 72, at 108.

85. In emerging countries with constricted insurance market, "microinsurance scheme", which has been proved to be successful in India, has been proposed to provide with basic financial protection for people in poverty. IAIS & CGAP Joint Working Group on Microinsurance, *supra* note 78.

hybrid microinsurance becomes an essential prototype in developing catastrophe insurance for climate change. This should be developed as soon as possible to cope with the dramatic increase in risks resulting from climate changes.

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## 氣候變遷之調適與保險機制： 建構台灣可行之巨災保險模式

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### 摘 要

為降低因氣候變遷所導致之巨災風險，保險自當為移轉跟分散風險之主要角色。雖於科學與相關論證已少有對於氣候變遷係導因於人類活動而致使全球溫度上升，但仍難以準確預估溫室氣體效應所帶來之影響。此項問題更導致難以預估對於氣候變遷有關極端氣候所致之經濟損失，同時保險產業也難將有關巨災風險模型化以準確估計保險費。

此外，由於氣候變遷風險之不確定性將嚴重影響侵權行為所導致損害賠償責任之可保性，因此勢將討論如何適當分配巨災風險。以責任保險模式建立在侵權行為與環境責任為例，該項模式不僅應考慮侵權行為歸責原則（如過失責任、嚴格責任或追溯責任），更應注意到因果關係有無之舉證責任等。因此責任保險之適當性往往取決於氣候變遷有關之侵權行為責任相關訴訟之基礎上。

另一方面而論，以補償為基礎之保險制度（如補償機制或強制保險等）似可直接補償氣候變遷受害者。實際上，關於以補償基礎之保險制度，已有不少巨災保險（如地震）可被引介為因應氣候變遷風險之保險模式。

本研究即主要討論以溫室氣體排放者侵權損害賠償責任為基礎之責任保險以及以直接保障氣候變遷受害者之補償保險。同時並以台灣為例，提出因應氣候變遷風險之可行保險模式。

**關鍵詞：**氣候變遷，巨災保險，侵權行為、責任保險、因果關係、微型保險、環境責任

