



# Adaptation through insurance: lessons from the NFIP

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## Abstract

**Purpose** – Insurance is widely regarded as a key adaptation option for climate change. Yet, the experience of the insurance sector in dealing with climatic hazards, particularly flooding, has been highly varied. Drawing from the experience of the US National Flood Insurance Program (NFIP), the purpose of this paper is to identify opportunities and challenges associated with using insurance as an adaptation strategy for climate change.

**Design/methodology/approach** – This article critically reviews the history and recent performance of the NFIP and considers lessons for climate change adaptation through insurance.

**Findings** – The US NFIP offers government-subsidized flood insurance for firms and residences. Over its 40-year history, the NFIP has struggled with financial instability and low levels of public participation in the program. The experience of the NFIP offers several lessons regarding the viability of insurance as an adaptation strategy: increasing insurance premiums to account for new climatic risks may mean that a growing segment of the population is unable or unwilling to purchase insurance, absent some other form of subsidization; educating the public on levels of risk and promoting appropriate risk mitigation are highly effective means for reducing damages from current and emerging weather-related risks; and close public-private cooperation is likely to be needed to prevent withdrawal of private insurers from high-risk areas and to ensure that insurance coverage continues to be widely available.

**Originality/value** – Examination of past experience with insurance as a mechanism for climate adaptation offers lessons and insights that can inform development of effective strategies to address climate change.

**Keywords** Adaptation, Insurance, Floods

**Paper type** Viewpoint

## 1. Introduction

Adaptation to climate change has become a central policy issue for national, regional and local governments throughout the world. While climate change adaptation is often perceived as “terra nova” issue such that new policies, laws and institutional structures are needed to address adaptation needs, most societies have historically adapted to climate variability and change. Within the USA and Europe, a key mechanism for adapting to climate variability has been the use of insurance, and insurance is also widely cited as a potential climate change adaptation strategy for developing countries (Agrawala and Fankhauser, 2008; Dlugolecki, 2009; Geneva Association, 2009; Posey, 2009). By providing incentives for reducing risks and decreasing the adverse financial impacts of climatic events, insurance can be an important factor in diminishing climate-related losses (Mills, 2007). Yet, insurance programs may also impede adaptation or promote mal-adaptation, particularly, if programs are poorly designed or have premiums that do not reflect actual risk (Agrawala and Fankhauser, 2008).

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In an era of climate change, the insurance sector also faces its own suite of vulnerabilities. The effects of climate change, including increases in natural hazards, bring forth dire issues that the insurance industry must address if it is to be a viable adaptation option (Mills, 2005). The largest risk to insurers is that climate change is rapidly shifting the probabilities of loss (Dlugolecki, 2009). Major weather events are occurring more frequently than in the past, resulting in reduced time to recoup costs. Changing spatial distributions of hazards and increased intensity of events result in exponential increases in damages, which in turn impact the effectiveness of insurance. Insurers who rely on past weather data and event histories may have particular difficulty in coping with new risks under climatic change. Moreover, in most countries, the insurance industry is highly regulated particularly with regard to pricing of premiums, which limits the ability of insurers to adjust premium prices based on new evidence of climate change risks.

In response to these challenges, private insurers worldwide have begun to assess how to remain effective and profitable in a changing environment. As the risks of damages rise, insurers are increasingly citing the need to raise premium rates, lower limits of coverage, and in some cases, withdraw completely from certain markets (IPCC, 2007; Lloyd's, 2006; Mills, 2009). There is also increasing discussion of the need for public-private insurance partnerships to spread financial risks and regulate land use in high-risk areas (Huber, 2004; Michel-Kerjan and de Marcellis-Warin, 2006). While insurers must adjust to the changing circumstances that an era of climate change will bring, these adjustments will in turn have effects on the viability of insurance as an adaptation strategy.

This article examines the US National Flood Insurance Program (NFIP) and considers lessons that the program offers for efforts to use insurance as a mechanism for climate change adaptation. Although the NFIP has been criticized for the problems that it has faced in its 40-year history, the program is a valuable resource for learning about public-private partnerships and the role that insurance may play in reducing climate-related losses. Furthermore, because future adaptation strategies and plans are likely to be modeled based on existing policies and programs aimed at disaster risk reduction (O'Brien *et al.*, 2008; Schipper and Pelling, 2006), the experience of the NFIP provides insights into the opportunities and pitfalls of using insurance as a primary means of protection against climate change risk.

## 2. Background on the US NFIP

The risk of flood is a common problem and threat to communities worldwide (Few, 2003). In the USA, the trends of total flood damage and per capita flood damage show statistically significant increases since 1934 (Pielke *et al.*, 2002). In current US dollars, flood damages have increased from \$19 million in 1934 to over \$1.3 billion in 2000. During the decade of the 1990s, total flood damages were close to \$50 billion for the nation. On a larger scale, the global damages from present day weather events already top \$200 billion per year (Dlugolecki, 2007). Failing to adapt to the effects of climate change are expected to result in significant increases in weather damages worldwide (Geneva Association, 2009).

Under most scenarios of climate change, extreme precipitation events are expected to increase in both frequency and magnitude. For coastal regions, the threat of flooding is compounded by the prospect of sea level rise, leading to higher surges and greater

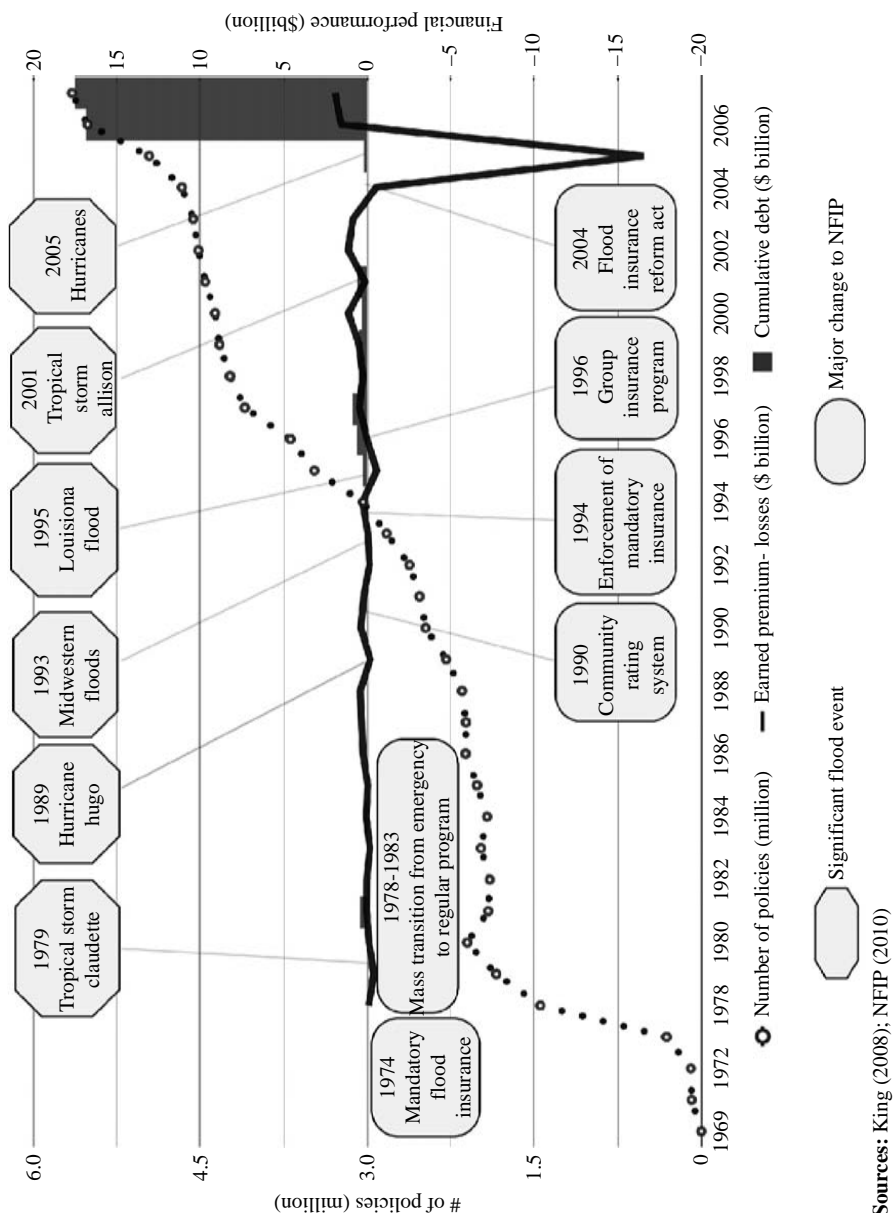
flooding damages during storm events. Given that flood damages are highly likely to occur and losses have the potential to be catastrophic, the public in most developed countries has been either unwilling or unable to pay high premiums (Anderson, 1974; Browne and Hoyt, 2000; McLeman and Smit, 2006). Hence flood peril is excluded from available property insurance by private insurers in the majority of the developed world (Browne and Hoyt, 2000). In many industrialized countries, flood insurance, much like earthquake insurance, is provided by the state. One of the few exceptions is the UK that has privately insured flood hazards for the past 50 years. However, even the UK has been facing recent pressures to increase governmental participation in insuring against the rising costs of flood damage (Huber, 2004).

The US approach to flood insurance has been the development of federally backed flood insurance through the NFIP. Following the discontinuation of private flood insurance in 1929, damages from floods were on the rise and there was a need to develop strategies to decrease losses, discourage uneconomic development in floodplains and reduce the federal financial expenditure on flood relief. After years of legislation and studies that assessed the feasibility of federal flood insurance, US Congress passed the National Flood Insurance Act in 1968 that launched the NFIP.

Based on the recommendations of the Task Force on Federal Flood Control Policy, the strategy of the NFIP was to spread financial responsibility for flooding among those communities at risk to floods. This strategy was implemented to combat the rising costs of flood loss at the federal level by encouraging less risky use of floodplains and decreasing the costs of taxpayer-funded disaster relief. The program was intended to be part of a multi-faceted strategy to combat flood damages that included coordination and planning of new construction in floodplains and changing federal policy regarding flood loss funding at the state and local scale. Communities that voluntarily adopted and enforced general floodplain management strategies would be eligible to purchase federally backed flood insurance. When first implemented, federally subsidized flood insurance was made available to small businesses, churches and residential structures. Since its 1968 launch the NFIP has expanded and now provides flood insurance to states, businesses, and residences.

Figure 1 shows a timeline of the history of the NFIP, identifying major flood events, participation levels, and financial conditions. Examination of the NFIP history reveals a tendency to implement major changes to the program following significant flood events. The most comprehensive changes were made by the 1973 Flood Disaster Protection Act, prompted by Tropical Storm Agnes, and in 1994, following the Midwestern Floods of 1993. These changes were aimed at increasing participation and improving financial stability of the program through the implementation of initiatives focused on mandatory flood insurance and more stringent flood management standards.

As revealed by Figure 1, financial stability has historically been a major concern of the NFIP with significant levels of debt and inability of earnings to consistently exceed losses. The NFIP originally planned to become self-sufficient by covering operating expenses and flood insurance claims with policy premiums rather than depending on tax dollars for funding (FEMA, 2005). However, since its inception, the NFIP has relied heavily on government subsidization of premium rates and is thus not actuarially sound (Bingham *et al.*, 2006). Although the NFIP has been financially self-sufficient for much of its 40-year history, the long-term financial stability of the program is uncertain. The disastrous floods of 2004 in the Southern and Eastern USA along with the catastrophic



**Figure 1.**  
NFIP program  
participation and financial  
performance 1969-2007

hurricanes of 2005 that affected Florida, Louisiana, Texas and Mississippi wiped out NFIP reserves and exposed the financial instability of the program. The other major challenge for the NFIP has been the historic low levels of public participation in the program. While the number of policies has grown from less than 20 in 1969 to over 5.7 million in 2007, it is estimated that less than one half of all properties with greater than 1 percent risk of being flooded each year are covered by flood insurance (Dixon *et al.*, 2006).

### **3. The NFIP and climate change challenges**

During its 40-year history, the NFIP has implemented a number of strategies to increase participation in the program and improve financial stability. Examination of each of these strategies provides insights into the types of challenges that the NFIP may face in a changing climate.

#### *Increasing participation through program wide changes*

Participation has been a continuous challenge for the NFIP, yet efforts to increase participation have sometimes had unintended consequences. In order for communities to participate in the NFIP, flood insurance rate maps (FIRM), which mark special hazard areas and risk premium zones, must be developed to show areas that are vulnerable to flooding (FEMA, 2005). In its initial stages, while FIRM were being created for communities at risk, an emergency program was established to allow communities to join the program in the interim. This emergency program utilized less detailed maps, based on existing local information, to estimate areas at risk while communities received limited insurance and paid federally subsidized rates. Property developments that were started before FIRM were created would be grandfathered into the program and be exempted from compliance with new building standards. However, after moving from the emergency program to the regular program, communities would be obliged to comply with standard NFIP criteria including higher premiums and possible restrictions on future development.

While the emergency program was initially conceived as a temporary method to increase participation in the program, the NFIP faced considerable delays in transitioning communities from the emergency program to the regular program. In the early years, the number of communities participating in the emergency program far outnumbered those in the regular program. Despite the concentration of funding and attention paid to developing FIRM, until the late 1970s, over 80 percent of communities remained in the emergency program. By 1983, when the emergency program was initially projected to end, over 15 percent of communities were still awaiting FIRM and had yet to transition to the regular program. Delays in completing FIRM resulted in continued development in at-risk locations. Furthermore, properties that were constructed pre-FIRM were grandfathered into the NFIP and were subjected to subsidized insurance rates that did not reflect their level of risk. These grandfathered properties have expected losses that are over five times higher than losses from properties that meet FIRM criteria (Jaffee, 2006). Currently, the emergency program is still utilized as the first step for communities to enter the NFIP and 1 percent of all communities await FIRM development (GAO, 2008).

The characteristics exhibited by the NFIP in the transition from the emergency to regular program provide learning points for future efforts to implement mass changes to the program. This transition exposed the significant delays and repercussions encountered when implementing change to a large number of program participants.

The setbacks in producing FIRM resulted in large numbers of subsidized rate properties that do not meet building standards, are highly likely to experience repeat losses and are currently a significant financial burden to the NFIP. The emergency program, initially planned as a temporary measure, has evolved into an official phase in community participation in the NFIP.

The NFIP is currently engaged in another mass transition from outdated paper maps to more accurate digital maps. This map modernization process, initially expected to be completed by 2009, has encountered considerable challenges and delays, continuing the trend of significant impediments when implementing program wide change (FEMA, 2006; NFIP, 2010). Setbacks in the map modernization process will likely result in the continued addition of grandfathered properties into the program, much like that experienced previously. In an era of climate change, as the number of communities exposed to flood risk increases, the major delays in producing new maps may also lead to communities with outdated maps becoming an official phase of the NFIP. Just as there are different coverage limits and premiums for communities in the emergency program, there may also be different rules implemented for communities awaiting updated maps.

#### *Increasing participation through mandatory insurance*

A major strategy utilized to increase participation in the NFIP has been the mandatory purchase of flood insurance. From 1968 until 1973, the purchase of flood insurance was entirely voluntary. However, the destruction wrought by Hurricane Agnes in 1972, of which less than 1 percent of insurable damage was covered by the NFIP, spurred a change in policy. Beginning in 1974, property owners with structures in special flood hazard areas (SFHA) were required to purchase flood insurance if utilizing a federally related financial assistance program. The lending agents that provided these financial programs would be responsible for enforcing this requirement. As Figure 1 above shows, there was a sharp initial increase in program participation following the implementation of mandatory flood insurance.

However, subsequent enforcement of this requirement was mediocre at best. Studies on adherence to mandatory purchase of flood insurance found that less than 40 percent of properties required to purchase flood insurance took out flood insurance initially or maintained insurance after the first year (GAO, 1990). Banks were neither penalized nor incentivized to enforce the regulations. In 1991, efforts were made to increase compliance with mandated insurance by allowing lenders to purchase flood policies for SFHA properties whose owners had refused to purchase insurance. In 1994, NFIP threatened lenders with monetary penalties if they did not ensure that flood insurance was maintained over the life of the loan. These changes have resulted in improved adherence to mandatory purchase (Chivers and Flores, 2002; Tobin and Calfee, 2005). Figure 1 shows another significant increase in program participation following the enforcement of mandates. However, while compliance with mandatory flood insurance has increased, there is still room for improvement. Determining if a property is located within SFHA, providing information to owners that will spur purchase of flood insurance, assisting owners with securing funds to cover insurance premiums and tracking that coverage is maintained for the life of the loan are only some of the difficulties that lenders have cited when enforcing mandatory flood insurance.

In changing climate, the difficulties faced with enforcing mandatory flood insurance may be compounded. As more areas are exposed to flood risk, there will be additional



properties subject to mandatory flood insurance as well as properties at risk to flood that will not be obliged to purchase insurance. Research has shown that most floodplain dwellers do not purchase insurance voluntarily (Kunreuther and White, 1994). Even those purchasing property subject to mandatory flood insurance are often unaware of flood risk or available insurance options (Chivers and Flores, 2002). If the perceived threat of flood is not great, floodplain dwellers believe that floods will not affect their property or that damage will not be severe. The problems that lenders currently face when trying to enforce and track mandatory flood insurance requirements are also likely to affect those not required to purchase flood insurance but who are still at risk to flood. Determining whether or not to purchase flood insurance and continuing to maintain insurance after the initial year are issues that will confront a growing segment of the population. The mediocre compliance of those that are required to purchase flood insurance exposes the likely difficulties in adoption of flood insurance by the increasing population exposed to flood risk but not required to participate in the NFIP.

#### *Addressing financial drains*

Maintenance of financial stability has been another key challenge for the NFIP. One of the major expenses of the NFIP has been repetitive-loss properties that pay subsidized insurance rates and receive payouts for damage from multiple floods. Although multiple loss properties comprise only 1 percent of all properties that the NFIP insures, they account for approximately 30 percent of claims (GAO, 2004). Since 1978, over \$4.6 billion in claims has been paid to owners of repetitive-loss properties. Many of these properties were developed pre-FIRM and have been grandfathered into the program (Burby, 2001).

To address this major financial drain, a task force was created in 1998 and by 1999 a new facility was established to monitor repetitive loss policies and mitigation activities. In subsequent years, the NFIP proposed to enforce a number of strategies aimed at repetitive loss properties including charging actuarial rates, limiting the number of claims, ceasing to provide flood insurance and increasing deductibles. The Flood Insurance Reform Act of 2004 established a temporary program that provided funds to mitigate or purchase the most costly repetitive loss properties (GAO, 2004). Only then was the NFIP authorized to increase premiums and deductibles of repetitive-loss properties to actuarial rates if property owners refused to implement flood mitigation measures. The need for voluntary acceptance of mitigation measures by property owners along with inaccurate property information has made the process of mitigation difficult and slow. While some repetitive loss properties have been mitigated, the rate of new properties being classified as repetitive loss has outpaced mitigation activity by 10 to 1 (GAO, 2008). In addition, approximately \$1.8 billion is needed to mitigate the remaining repetitive loss properties (Department of Homeland Security, 2009).

The NFIP experience with repetitive loss properties reveals a number of shortcomings of the program. Although repetitive loss properties have been a problem since early in the program, strategies to address the issue only began in 1998 and organized action did not start until 2004. The long time period needed to recognize and address this significant problem has been attributed to a lack of comprehensive review and analysis of the program. The 1966 NFIP Task Force initially recommended that any insurance program undergo a feasibility study to include testing and refining the program on a smaller scale before being implemented on a national scale. However, the NFIP was launched nationally without the advised feasibility study (Kunreuther and White, 1994).

The first appraisal study of the program in its entirety did not take place until 2001, more than 30 years after its commencement (Chivers and Flores, 2002). This lack of comprehensive analysis has resulted in piecemeal, as-needed fixes to the NFIP and no holistic overhaul of the program. In an era of climate change, as flood damages are expected to increase, the NFIP will need to better recognize and address costly issues with the program.

### *Premium rate adjustment*

Yet, another historical strategy used to both address financial stability and increase participation in NFIP has been to adjust insurance rates. This strategy has been spurred by low community participation and continued economic losses from floods (FEMA, 2005). In 1972, subsidized rates for flood insurance were lowered by approximately 40 percent, followed by another rate decrease as part of the 1974 changes to the program. However, these highly subsidized rates threatened the ability of the program to become financially self-reliant. Thus, rate decreases were abandoned and increases began in 1981 when pre-FIRM structures underwent a 20 percent rate increase. This was part of a long-term effort to decrease federal subsidization of NFIP and make the program self-supporting by 1988. Since the launch of the NFIP in 1969 until 1988, insurance premiums increased by 120 percent. More recently, in late 2009 NFIP imposed average premium increases of 8 percent and also increased deductibles and insurance limits. Shifting rates to more closely reflect actuarial rates is seen as an essential step in improving the financial status of the program (GAO, 2008).

Throughout its history, the NFIP has also adjusted rates through implementing programs that aim to limit loss claims and increase the number of policyholders. In 1990, the Community Rating System (CRS) was introduced. The CRS provides discounts of up to 45 percent on premiums for communities that voluntarily execute activities to reduce flood losses or that increase the number of policies held in the community. While currently over 60 percent of communities participate in CRS, there have been no linkages found between participation in the program and an increase in community policies (FEMA, 2005). However, the mitigation efforts of communities have resulted in decreased losses from floods. The introduction of Group Flood Insurance Policies in 1996 was another program implemented to limit losses and increase policyholders. This program allowed low-income property owners in SFHA to obtain flood insurance for three years at a deeply subsidized rate (FEMA, 1999). However, although participants in the Group Flood Insurance program are required to purchase individual flood insurance after the initial three years, reports have found that this rarely occurs (FEMA, 2005).

The historical strategies of the NFIP to decrease losses while improving participation show that while increasing premium rates may contribute to financial stability of the program, it may also result in decreased overall participation. Increasing rates causes decreases in voluntary participation and policyholders often choose to limit their coverage to retain affordability (GAO, 2003). Other studies have shown that flood insurance purchases increase with income and decrease with rising prices (Browne and Hoyt, 2000).

In an era of climate change, the problems that the NFIP has faced in trying to improve financial stability while also increasing participation takes on new significance. The very premise of the NFIP, that those at risk to flood should bear the costs of losses,



is de-centered by climate change. The impacts of climate change, including shifting participation patterns, extreme events and sea level rise, are expected to result in an increase of communities at risk to floods. This raises equity issues as to whether these communities that are now affected by a globally induced problem should be the sole bearers of responsibility for the consequences. Although the subsidization of rates is used to make flood insurance equitable, as Figure 1 shows, the financial instability of the program has required rate increases to cover the rising costs of flood loss. While rate decreases were enacted in the beginning of the program to encourage participation, it is becoming increasingly evident that rate subsidization is no longer a viable option. Thus, the incorporation of new at-risk communities into the NFIP raises a number of equity concerns that are not easily addressed.

#### **4. Lessons for adaptation through insurance**

The experience of the NFIP and the future challenges it faces offer valuable lessons for relying on insurance as an adaptation strategy. As private insurers assess their vulnerabilities to climate change and how they can best respond to the changing environment, three major issues are increasingly cited: the rising costs of providing insurance, the need for more effective risk mitigation and greater reliance on government-provided insurance. The NFIP offers lessons for how the responses of private insurers to the vulnerabilities they face may impact the viability of insurance as a method of adaptation.

##### *Rising costs*

In an era of climate change, sea level rise, shifting weather patterns and increased frequency and intensity of extreme events are expected to result in exponential increases in risk of property damages from a myriad of natural hazards (Dlugolecki, 2009). Since private insurers operate using actuarial, risk-based rates, greater risks will result in increases in insurance premiums, lower deductibles, lower limits of payout and broader coverage restrictions (Lloyd's, 2006; LeBlanc and Linkin, 2010; Mills, 2009). These changes in terms are deemed necessary by insurance companies in order to remain profitable and able to fulfill claims when damages do occur. Although regulators and policy-makers monitor the raising of rates, as the risk of damages increases so too will the justification for increased premiums (Litan, 2006).

While the increased risk of damages may correspond with the need for insurers to raise rates and reduce coverage, the experience of the NFIP shows that raising rates may have unintended consequences. As shown by the financial instability of the NFIP, actuarial rates that accurately reflect risk are needed to maintain financial soundness. However, the experience of the NFIP also shows that raising rates can result in decreased participation in insurance programs. As the price of attaining flood insurance increases, some property owners choose to limit or decline coverage. Additionally, as time passes without a flood event, property owners often devalue their level of risk, perceive insurance as too expensive and resultantly decrease their coverage (Michel-Kerjan and de Marcellis-Warin, 2006). As the cost of insuring property increases and more property is placed at risk to weather damage, a growing segment of the population may be unable to afford insurance. Thus, the use of insurance as an adaptation strategy for lower income populations that are at risk to weather-related damage may not be a viable option without some other form of premium subsidization.

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### *Risk mitigation*

In addition to the changing environment, the increase of population and property in high-risk coastal areas contributes to increases in damages and risk (Pielke *et al.*, 2008). More and more people are located in coastal areas where risk is high, resulting in increased economic damages when extreme events do occur. As a result, insurance companies cite the need for more effective risk mitigation such as regulating land use in high risk areas or requiring physical mitigation of properties (Lloyd's, 2006; Michel-Kerjan and de Marcellis-Warin, 2006; Pielke *et al.*, 2008).

The NFIP shows that a major issue in effective risk mitigation is that people are often unaware of their risk to hazards. Attempting to relay the risk of flood by requiring mandatory flood insurance revealed that until property owners were made aware of the legal requirements of flood insurance, they were often incognizant of the risk. The experience of the NFIP also revealed that deliberate efforts to reduce flood losses including the physical mitigation of properties resulted in decreased damages and losses. Threatening to charge actuarial rates for property owners that refused to implement mitigation measures also resulted in action to protect properties against flood damage.

The NFIP experience shows that risk mitigation can be effective providing that there is awareness of risk and an incentive to mitigate. Varying premium rates to acknowledge effective risk mitigation measures provides an explicit indicator of the importance of mitigation (Botzen and van den Bergh, 2008). Mitigating properties against hazards provides a considerable reduction in risk and resultant damages (CCSP, 2009; Young, 2009). Increased government involvement in educating the public about weather risks and enforcing stricter building codes can also aid in relaying levels of risk and decreasing damages (LeBlanc and Linkin, 2010). Effectively communicating the risks associated with certain areas may even result in decreased populations in high-risk areas (Litan, 2006). Insurance as an effective adaptation strategy requires that people are aware of and take measures to reduce their risk to weather damages.

### *Government provided insurance*

Even with more expensive insurance and effective risk mitigation, as risks and damages increase property owners may be unable to rely on the private market to provide insurance. Private insurers are not legally obligated to provide coverage in high-risk areas and are free to withdraw from the market (LeBlanc and Linkin, 2010). Catastrophic weather events and their related damages may incite private insurers to decline coverage against certain types of risks or in certain places (Michel-Kerjan and de Marcellis-Warin, 2006). As private insurers deem risks as too high or markets as unprofitable, withdrawal from the market is viewed as an acceptable adaptation option (Litan, 2006; Lloyd's, 2006; LeBlanc and Linkin, 2010). Indeed, market withdrawal is not a new strategy as the 1929 discontinuation of private flood insurance was a contributing factor in the development of the NFIP. More recently, private insurers have withdrawn from high-risk regions including coastal areas of Florida and Texas leaving thousands without insurance coverage (Mills, 2009; LeBlanc and Linkin, 2010). After the withdrawal of private insurers, the government is often expected to step in and provide coverage as insurer of last resort (Michel-Kerjan and de Marcellis-Warin, 2006; Botzen *et al.*, 2009).

The experience of the NFIP shows that relying on government provided insurance after the withdrawal of private insurers may not be a viable option. After the withdrawal

of private flood insurance in the USA, almost 40 years passed before the NFIP became operational. The history of the NFIP experiences with increasing participation and addressing financial concerns show that there are often lengthy and costly transitional periods needed to establish functional insurance programs. These experiences reveal that relying on the government to provide insurance if private insurers choose to decline coverage will not be a seamless process. There may be a long delay between the loss of private insurance and the availability of government insurance. A windfall of properties in need of insurance may overwhelm the capabilities of government provided insurance programs, much like the problems experienced with the NFIP emergency program and more recently with the transition to digital maps. Additionally, the significant financial problems of the NFIP along with other government insurance programs such as Florida's Citizens Property Insurance Corporation show that the government may be unable to finance insuring a boon of properties against ever increasing risks (LeBlanc and Linkin, 2010).

To prevent the continuation of private insurance withdrawal and to limit dependence on government insurance, there has been a call for greater public-private cooperation. A layered public-private system, where private insurers provide coverage up to a certain limit of damages followed by government provided insurance, has been proposed as an option for insuring against increased risks (Kunreuther, 2006; Litan, 2006; Botzen *et al.*, 2009). Another suggestion is to provide government grants to aid in property mitigation that would decrease risk and allow for continued coverage by private insurers (Young, 2009; LeBlanc and Linkin, 2010). The probable inability of the government to provide insurance if there is a mass withdrawal of private insurers shows the need for greater private-public cooperation to provide financially sustainable and effective insurance programs.

## 5. Conclusions

The ability of insurance to manage and spread risks by discouraging high-risk behavior is an essential component of reducing disaster loss (Mills, 2007). As such, insurance is increasingly advocated as a viable climate change adaptation strategy. Examination of how existing insurance programs such as the NFIP have addressed climatic risks and the challenges they face in an era of climate change offer important lessons for how to approach future climatic change. Review of the historic actions of the US NFIP shows how the program has broached difficulties in the past and exposes some of the issues that it has faced in its 40-year history. Some strategies used by the NFIP, such as the mass transition of communities from the emergency program into the regular program and enforcement of mandatory flood insurance, will need to be more efficient as the climate changes. Other strategies, however, such as rate subsidization, are de-centered by climate change and are not easily addressed by improving upon historic approaches. Furthermore, as the number of communities at risk to flooding increases due to the effects of climate change, the current approach to spreading financial responsibility may also need to be re-evaluated.

The experiences of the NFIP offer several lessons regarding the viability of insurance as an adaptation strategy as private insurers respond to the vulnerabilities that climate change exposes. First, rising risks of weather damage may justify increasing insurance premiums but will potentially result in a growing segment of the population that is unable or unwilling to purchase insurance, absent some other form of subsidization.

Second, educating the public on levels of risk and promoting appropriate risk mitigation are highly effective means for reducing damages from current and emerging weather-related risks. Finally, close public-private cooperation is needed to prevent withdrawal of private insurers from high-risk areas and to ensure that insurance coverage continues to be widely available.

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### Further reading

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