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Mitigation motivated by past experience: Prior hurricanes and damages

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Abstract

Hurricanes imposed a heavy toll on the U.S. in 2004 and 2005: damages from the four Florida hurricanes in 2004 exceeded Hurricane Andrew, while Hurricane Katrina was the costliest natural disaster in U.S. history. Researchers have spent years devising plans and mitigation measures to reduce damages from hurricanes. The lack of a reliable database on mitigation efforts has hampered assessment of the effectiveness of these measures [Mileti DS. Disasters by design. Washington, DC: Joseph Henry Press; 1999]. We propose a new test of the effectiveness of mitigation using a past landfalling hurricane as a proxy, since conventional wisdom holds that communities often implement mitigation after a disaster [Cutter S. Living with risk: the geography of technological hazards. London: Edward Arnold Press; 1993]. We find that a prior landfalling hurricane – and by implication mitigation – can significantly reduce damages, by the equivalent of about a one category reduction on the Saffir–Simpson scale of hurricane intensity.

1. Introduction

Hurricanes impose a heavy toll on coastal communities, from loss of life, the potential for billions of dollars of property damage, the disruption of the local economy,[1] and costly evacuations [4]. The cost of hurricanes to the U.S. has risen steadily over the decades [5,6], and the increase has occurred despite a reduction in the lethality of hurricanes. Much of the increase in property damage from hurricanes stems from dramatic increases in societal vulnerability, or the number of people and value of property in coastal counties. Many people value living or vacationing near the coast, and incomes in the U.S. has led more people to consume this amenity.

Escalating hurricane damages has led to interest among researchers, policy makers, and business leaders in ways to reduce losses. The interest in mitigating hurricane damages is just part of a larger emerging interest in adaptation to

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[1] A 2007 IPCC summary [3] asserts that the most vulnerable industries and populations are those located in flood plains, those with economies based on climate-sensitive resources, and those in areas prone to extreme weather events – especially where rapid urbanization is occurring. Most coastal communities in the United States qualify on several accounts.

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natural hazards in general. This has occurred due to the aforementioned increase in reported losses, as well as the rising importance of poverty reduction and emphasis on sustainable development. Natural hazards of all types, by damaging infrastructure and financial stability, threaten sustainability [7]. Until the 1970s, reduction of disaster risks was largely viewed as a struggle against environmental threats that required technological intervention. Today the focus is on understanding the human-environmental system [8, p. 44].[2]

Mitigation requires a shift of the public policy mindset from post-disaster assistance to pre-disaster planning [9].[3] The April 2007 Intergovernmental Panel on Climate Change report [3] states that adaptation will be necessary to address the impacts of future, unavoidable global warming due to past emissions. It suggests that future vulnerability can be reduced, but that a combination of more extensive adaptation and mitigation is necessary.[4] While many options are available, the limits and costs are not fully understood and there are increasing demands for evidence that mitigation "pays" [7].

Promising hurricane damage mitigation measures include land use planning, building codes, insurance, engineering and warnings [1]. But securing difficult to secure political support for mitigation is difficult without hard evidence on its cost effectiveness – that mitigation provides a positive expected net present value. Deyle et al. [12, p. 122] observe that "Many land use planning and development applications use information generated from hazard identification or vulnerability assessment rather than full scale risk analysis," or economic benefit cost analysis. Consequently they observe that policy makers rarely have sufficient confidence in the proposed measures to be "willing to make the difficult choices often required for hazard mitigation" (p.143).[5]

The lack of a reliable mitigation inventory hamstrings efforts to compare the benefits and costs of mitigation. Mileti [1, p. 12–3] states that a "database is needed to collate information on mitigation efforts – what they are, where they occur, and how much they cost – to provide a baseline for local cost-benefit analysis." Without knowing which communities enforce strengthened building codes or carefully regulate land use, researchers cannot prevent contamination of their control group or be certain which mitigation measures reduce losses.[6]

We propose an alternative way to test mitigation. Many hazard researchers agree that communities rarely respond to hazards and consider mitigation until *after* a disaster occurs.[7] While strengthening building codes after a hurricane or earthquake is akin to closing the barn door after the horses' escape, it should lead to reduced losses in *future* events. If this conventional wisdom is accurate *and* mitigation is effective, then hurricanes (and other hazards) which strike a community with prior hurricane landfalls should be less damaging, everything else held constant.[8] We test this hypothesis using landfalling hurricanes along the Atlantic and Gulf coasts of the U.S.

The above discussion assumes that mitigation takes the form of a public policy response, but actions by individuals could also reduce damages in the future. Home buyers, for example, might become aware of and willing to pay for

[2] Birkman [8, p. 58] states that the latest movement to create new economic indicators (such as the broadly used and accepted "GDP" and "unemployment rate") seeks to define sustainable development.

[3] Benson and Twigg [7] point out that many policy makers have been reluctant to commit funds to risk reduction, yet continue to provide considerable funds into post-disaster response.

[4] Benson and Twigg [7] state that most current methods consist of small-scale interventions and that vulnerability caused by socio-economic factors is almost completely ignored. The IPCC [3] states that poor communities, with limited adaptive capabilities, are especially vulnerable. The United Nations [10] suggests that a gender perspective "should be integrated into all disaster risk management policies." Sadowski and Sutter [11] explore the role of demographics in determining hurricane fatalities.

[5] Evidence on the benefits of mitigation is beginning to become available. A recent study found that Federal Emergency Management Agency mitigation projects had a benefit–cost ratio of over 4–1 [13] and that mitigation measures increase construction costs for new facilities by as little as 1–5%. Additionally, the U.S. Geological Survey estimated that a $40 billion investment in preventative measures during the 1990s would have reduced disaster losses by $280 billion [7].

[6] Recently Burby [14] has examined the effectiveness of state hazard planning mandates on insured losses in the U.S. based on a detailed survey of state planning legislation. His research makes progress on the inventory of mitigation measures and provides an important resource for hazards research. But surveys of statutes or building codes on the books have difficulty addressing the enforcement issue; for instance, South Florida had what was thought to be a very rigorous building code, until damage in the wake of Hurricane Andrew revealed that the code was not being enforced [1, p. 128–32]. Since laws on the books may still lead to misclassifications, our approach provides a useful complement to Burby.

[7] For example, Mileti [1, p. 148–9] notes that hazard warning systems "often are approved based on humanitarian sentiments after a particular emergency." Platt [15, p. 30] observes that "the aftermath of disaster offers a critical opportunity to review the choices available and possibly to select modification of the *status quo ante* to achieve protection from future disasters," and provides notable historical examples of this. See Ref. [2] for another statement of the conventional wisdom.

[8] Benson and Twigg [7] state that vulnerability is dynamic. The impact of recent disasters gives insight on current vulnerability, rather than future losses.