

Disaster Mitigation

Kevin M. Simmons, Ph.D.

Austin College

**Fulbright Research Scholar
International Centre for Geohazards
Oslo, Norway**

Economic and Societal Impacts of
TORNADOES

KEVIN M. SIMMONS AND DANIEL SUTTER



AMERICAN METEOROLOGICAL SOCIETY

Economic and Societal Impacts of Tornadoes

By Kevin M. Simmons and Daniel Sutter
© 2010, 296 pages in paperback
ISBN: 978-1-878220-99-8

AVAILABLE NOVEMBER 2010
from the American Meteorological Society
and the University of Chicago Press

AMS BOOKS

RESEARCH

APPLICATIONS

HISTORY

Research Agenda

- Interdisciplinary in scope.
 - Economics
 - Civil Engineering
 - Meteorology
 - Psychology
 - Sociology



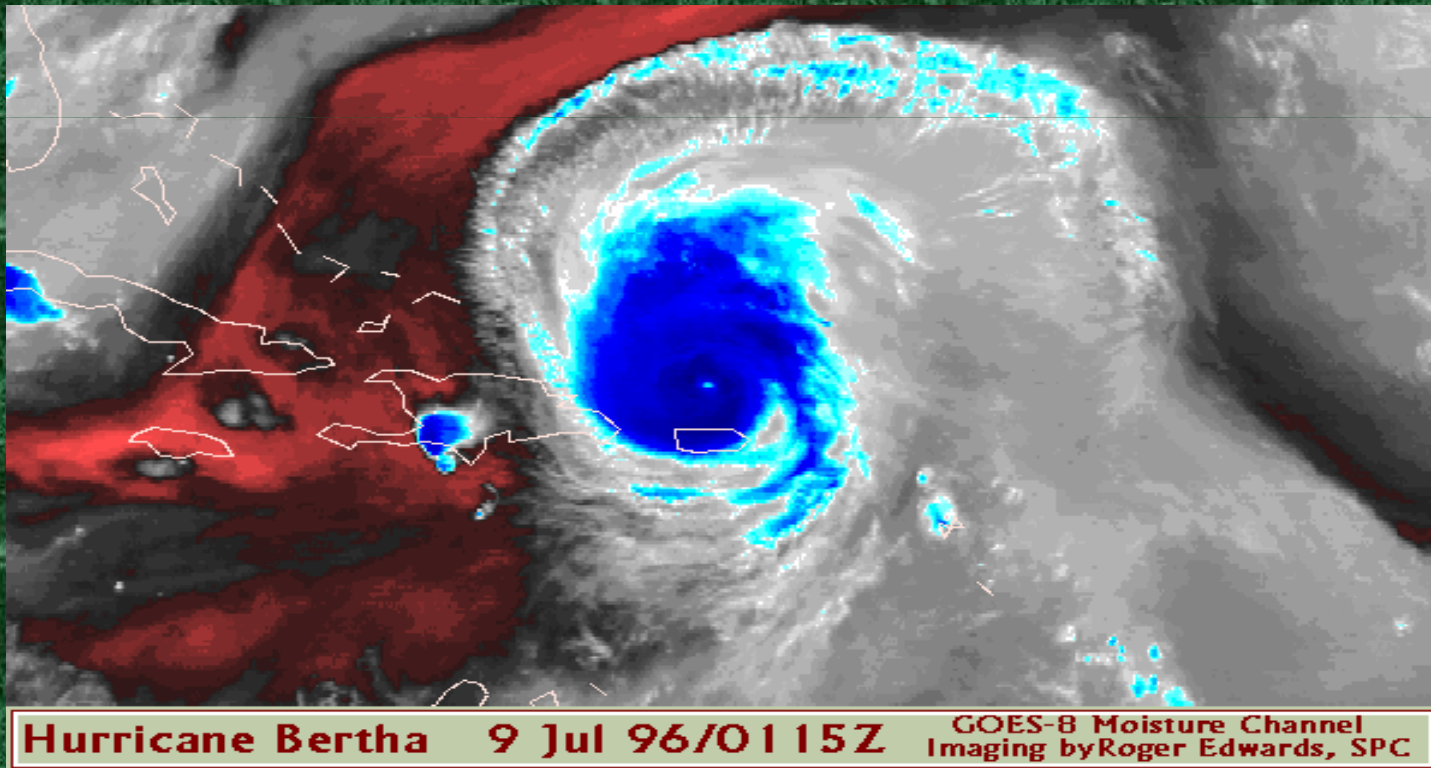
Research Agenda

- Government Partners
 - NOAA
 - USGS
- Corporate Partners
 - Institute for Catastrophic Loss Reduction
 - Institute for Business and Home Safety
 - Federal Alliance for Safe Homes
- Academic Partner Institutions
 - Economics:
 - Austin College
 - UT – Pan American
 - Texas Tech University
 - East Carolina University
 - Engineering:
 - Texas Tech University



Research Agenda

- Hurricane Mitigation Research
- Tornado Mitigation Research



Mitigation

- The theory behind disaster mitigation is a simple one: by making an investment of time, money and planning prior to the occurrence of natural disasters, there can be tremendous savings that result from reducing the impact of natural disasters when they inevitably occur. Brenner (1993)

Does Mitigation Matter?

- Habitation of threatened areas has increased.
- Even smaller storms can cause large damage.
- Engineering studies have consistently shown that inexpensive measures can have a large effect on damage reduction.

Carrot or Stick?

- Can market forces accomplish effective mitigation or is coercive policy the only option we have?



Jarrell, TX Tornado 27 May 97 2032Z
Tornado at photo time (3:32 pm CDT) is about 1 mi N of Jarrell, headed into town, as documented by storm chaser Lon Curtis. Image used by permission.

Increased Regulation

Let's try the stick!

- Discourage or disallow development of high-risk areas.
- Strictly enforced sufficient building codes.
- Increased building code standards.



Can we trust the market?

Let's try the carrot!

- For a market to function, there must be a demand for the product.
- Policy assumptions regarding mitigation was that little or no demand existed for mitigation measures.
- Without demand, reliance on market solutions is therefore futile.

What Does the Research Tell Us?

- Effectiveness of government mitigation programs (Oklahoma Saferoom Initiative)
- Effectiveness of new building codes (Florida)
- Market response to private mitigation alternatives

Hurricanes



Hurricane Market Mitigation Study

- Motivation:
 - Incorporate “societal impact” studies into research of wind related natural disasters.
- Funding:
 - National Science Foundation
 - Cooperative Project in Wind Engineering
 - Grant # CMS9409869
 - Additional Funding from FEMA

Hurricane Market Mitigation Study

- Examine the value of mitigation from three perspectives.
 - Theoretical
 - Empirical
 - Experimental



Hurricane Market Mitigation Study - Theory

- Purpose:
 - Theoretical studies attempt to create a mathematical model of human behavior and then examine how the model responds to changes in some of the variables in the model.

Hurricane Market Mitigation Study - Theory

- Basic Theory: Dixit (1990), *Optimization in Economic Theory*.

Result: With full insurance, there is no value to mitigation.

- Modified Theory: Simmons and Kruse (2000), *Journal of Economics*.

Result: Assuming deductibles and intangible losses, mitigation has a positive value.

Hurricane Market Mitigation Study - Empirical Study

- Purpose:
 - Empirical studies collect data which can show researchers the actual effect of decisions made by individuals.



Hurricane Market Mitigation Study - Empirical Study

- Location: Galveston, Texas
- Hurricanes on Galveston Island:
 - Galveston has a long history of hurricanes including two of the most deadly hurricanes ever recorded.
- Data:
 - MLS sales data from 1992 to 1997
 - Historical hurricane data from the National Hurricane Center

Hurricane Mitigation Study

Empirical Study

- Two separate measures of mitigation were studied.
 - Eng. Assessment of the survivability of one home versus another.
 - Obvious mitigation: Storm Shutters.

Hurricane Market Mitigation Study - Empirical Study Results

- Homes with obvious hurricane mitigation features sell on the market at a premium to homes without mitigation.
- This result is independent of hurricane activity, although more pronounced after an event.
- Homes with a greater resistance to wind forces sell on the market at a premium to homes with lower resistance to wind forces.

Hurricane Market Mitigation Study - Experimental Study

- Purpose:
 - Lab experiments are new to economics. Similar to lab experiments in the social sciences, the intent is to replicate human behavior in a laboratory setting similar to decisions made in everyday life.

Hurricane Market Mitigation Study - Experimental Study

- Procedure:
 - Study subjects were given a coupon worth actual money if they survived a lottery.
 - Prior to the lottery, they could purchase “mitigation” which would protect them in the lottery.
 - Several rounds were performed at “hit” probabilities ranging from 1% to 20%.

Hurricane Market Mitigation Study - Experimental Study Results

- Market price of mitigation exceeds expected value.
- Willingness to purchase mitigation increases as perceived risk increases.
- Willingness to purchase mitigation is independent of previous losses.

Hurricane Market Mitigation Study - Conclusions

- Contrary to previous research, hurricane mitigation does appear to have value to residents in high-risk areas.
- This value persists despite fluctuations in hurricane activity.

Hurricane Charley Building Code Performance



Project Overview

- Examine types of damage suffered by residential dwellings in Charlotte County
- Examine the effect of increased wind pressure on economic damages
- Examine the effect that various building code regimes had on economic damages
- Estimate *actual* avoided damages from better construction
- Estimate *potential* avoided damages from better construction

Data

- Data for this study was compiled by IBHS and obtained from county tax assessment rolls and building permit data
- Dataset contains information on over 53,000 residential dwellings in Charlotte County

Damage Variables

- Building permits issued in the 8 months after Hurricane Charley provides the basis for damage types
- There are 12 different types of permits
- These are summarized into 5 sub-categories: Internal, Roof, External, Residential Cage Enclosure, and Carport

Wind Field Data

- An estimate of the peak winds for each home is provided
- This estimate is divided into 5 categories:
 - Less than 120 mph
 - 120-129 mph
 - 130-139 mph
 - 140-149 mph
 - Greater than 149 mph



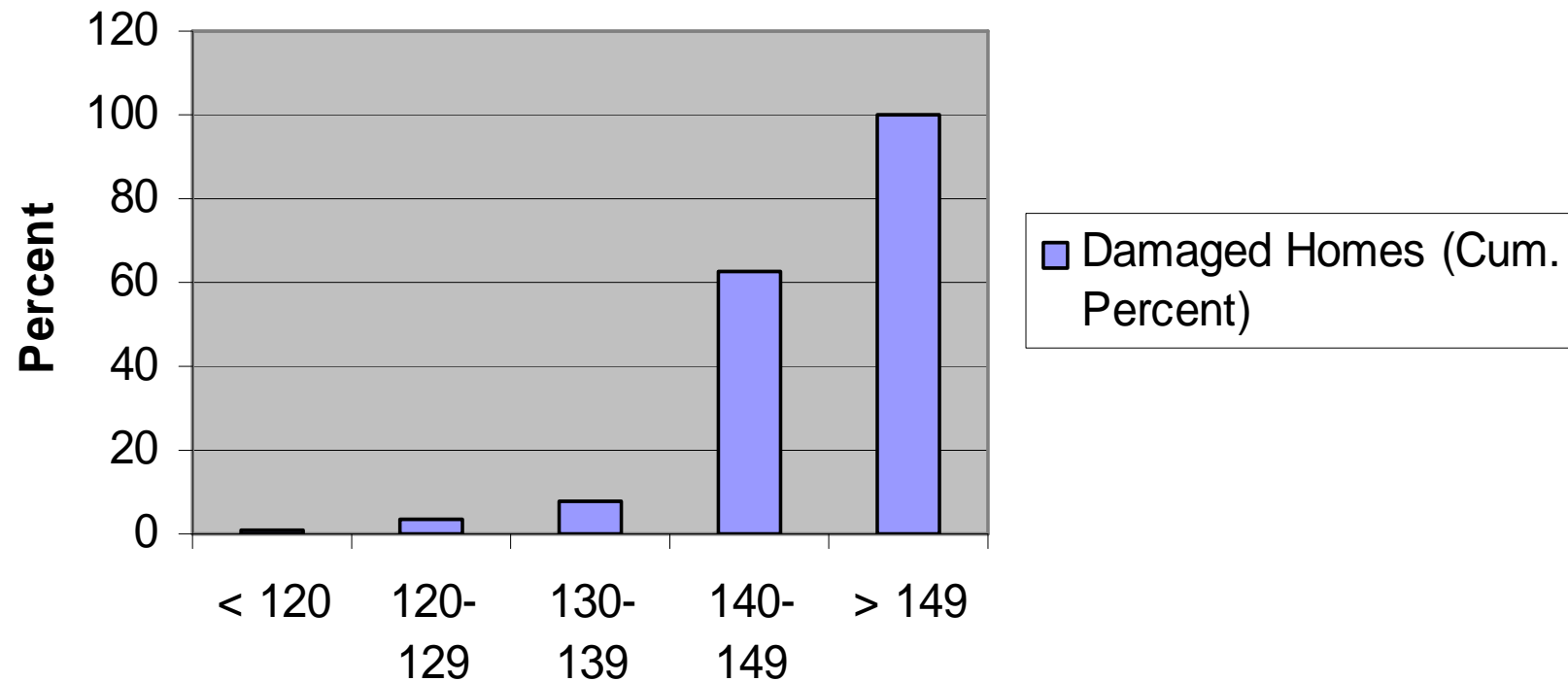
Year Built Categories

- Using the homes year of construction a series of 4 categories were derived to evaluate the impact of prevailing construction practices and building codes.
 - Pre 1980
 - 1980-1996
 - 1997-2002
 - Post 2002



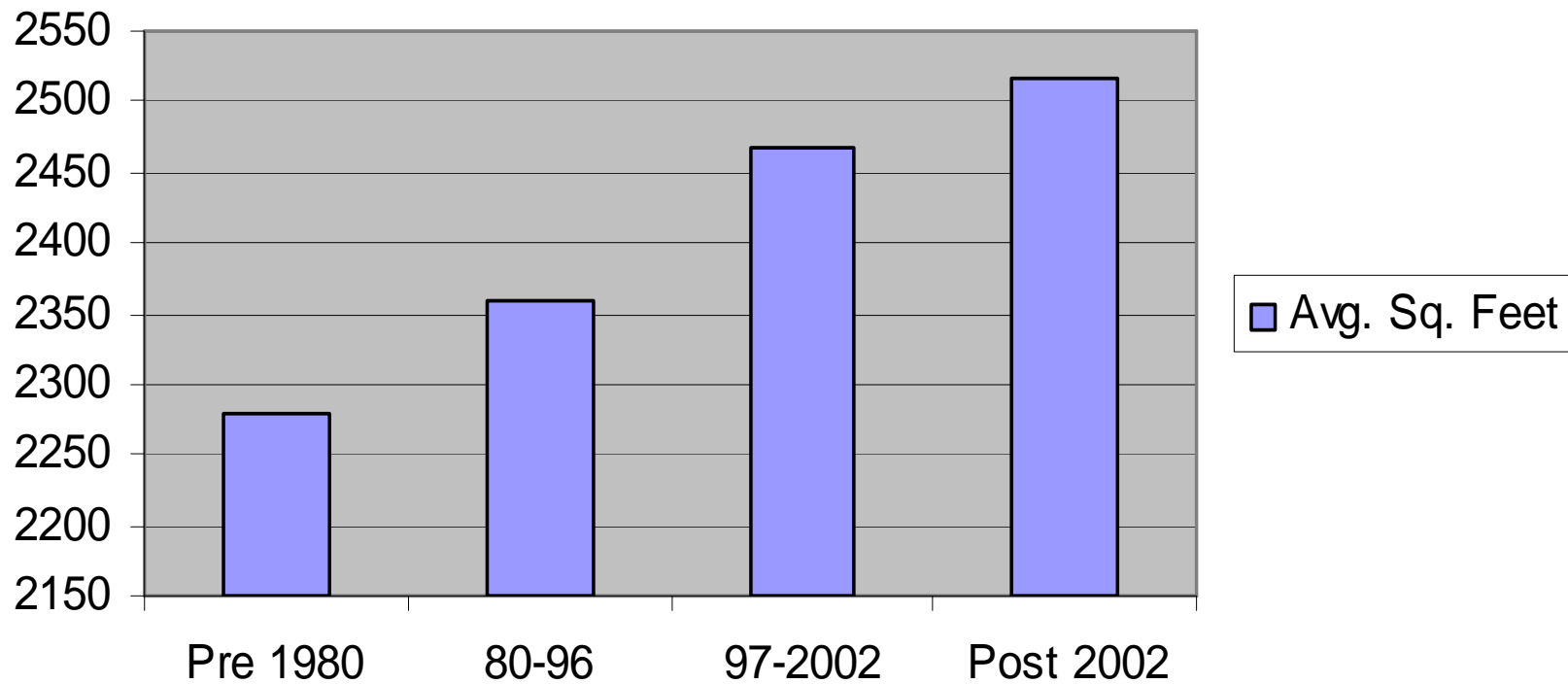
Overall Effect of Wind Speed on Damages

Damaged Homes By Wind Categories



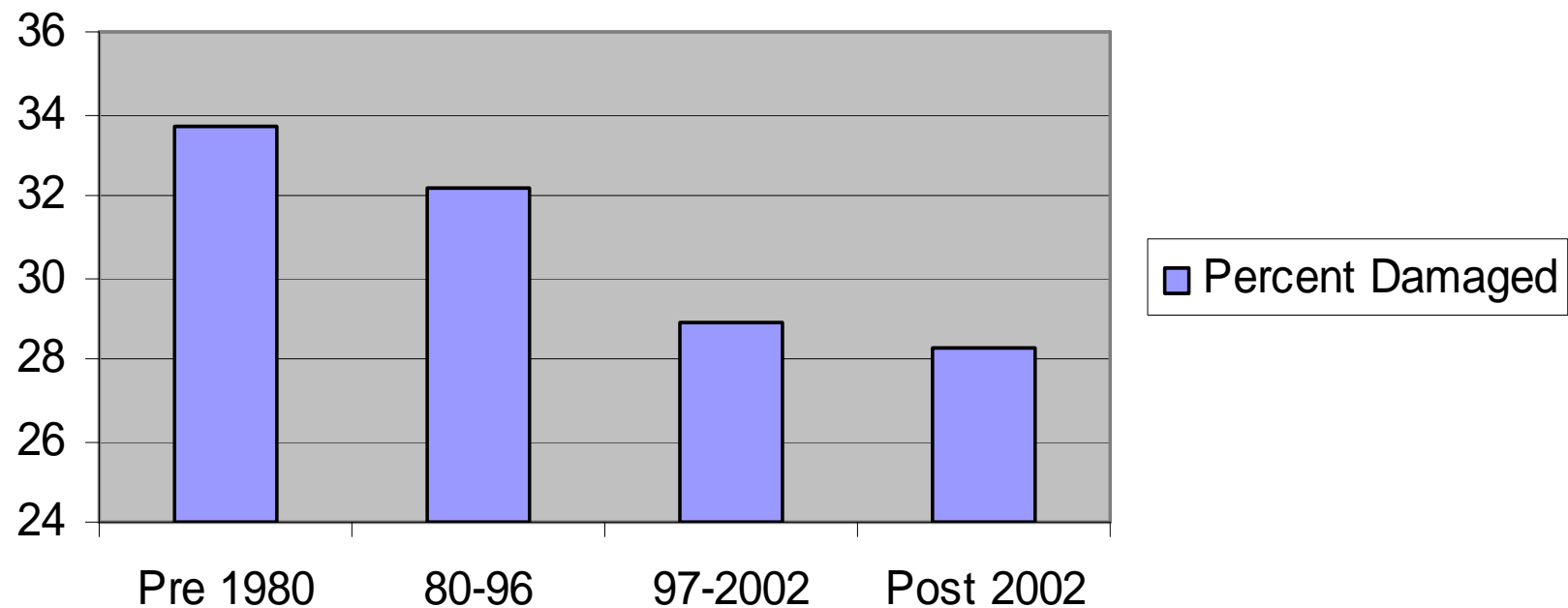
Average Home Size By Year Built Categories

Average Home Size By Year Built Categories



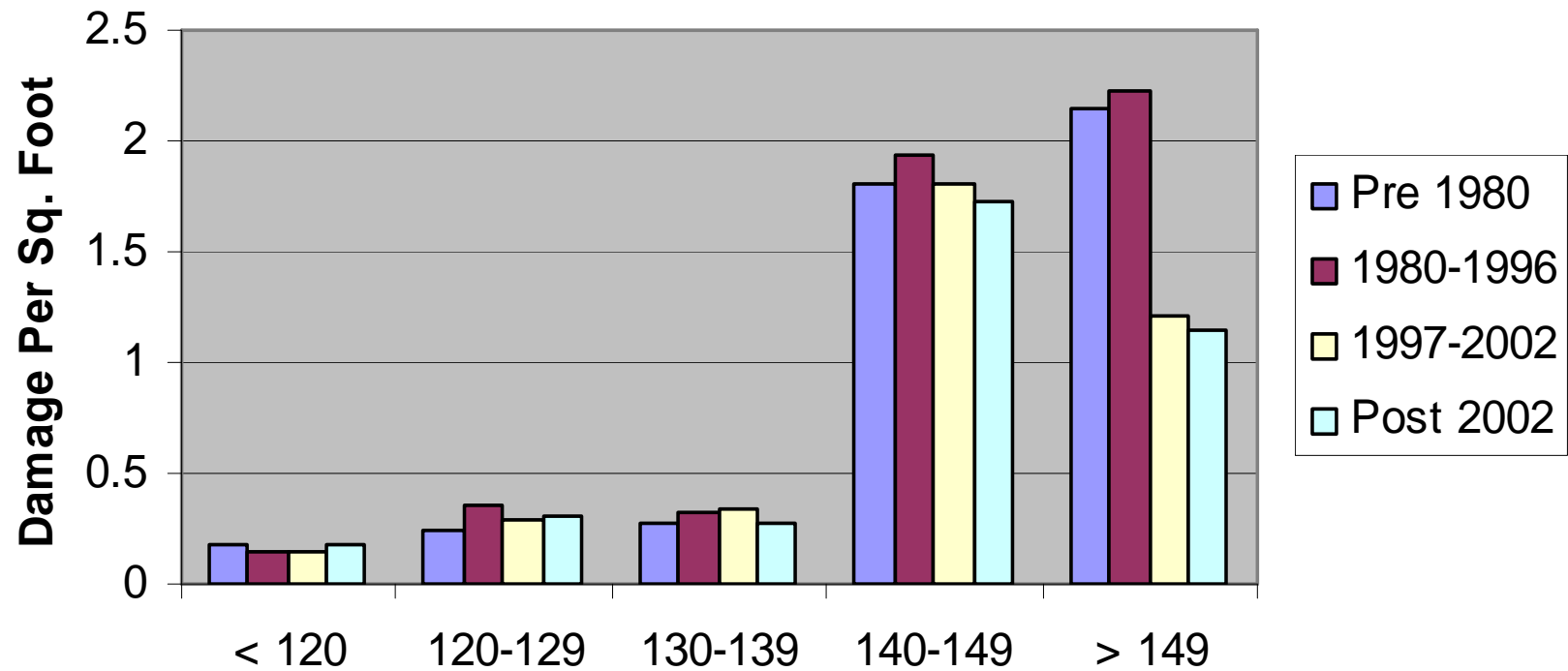
Damaged Homes (Percent) By Year Built Categories

Percent of Homes Damaged By Year Built Categories



All Homes – Damage Per Square Foot

All Homes - Damage Per Square Foot



Estimated Economic Impact of Post 1996 Construction

- We can estimate the effect of better construction by taking the avg. damage per square foot of homes built before 1996 for each Wind Category and applying that to homes built since 1996 for each category.
- Based on this, enhanced construction reduced damages from this storm by as much as \$14 million

Potential Economic Impact of Better Construction

- Using the same method we can estimate what the reduction in damages would have been if the best construction practices were in place in all homes.
- Potential damage reduction, based on this method, would have been as much as \$46 million or 25% less than the permit value of \$182 million

Potential Economic Impact of Better Construction

- Another useful comparison is to look at the difference between what estimated damages would be if all homes had been built to the best standards vs. all homes built to the worst standards. Estimated damage if all homes were built to the worst standards would be \$201 million vs. \$142 million if all homes are built to the best standards. This is a difference of \$59 million or almost 30%.

Study Conclusions

- Largest Determinant of Damage was Wind Speed
 - Damages increase significantly at peak wind speeds in excess of 140 mph
- Year Built Does Have a significant impact on damages
 - Homes built between 1980-1996 did not fare as well as Pre 1980 homes
 - Homes built after 1996 fared better with the homes built after 2002 doing the best

Tornadoes



Tornado Mitigation

- Analysis of Market and Policy actions following 1999 Oklahoma tornadoes.
- Market Acceptance of tornado mitigation.
 - ICLR Funded student project (Austin College)
 - ICLR Funded real estate sales project. (OU)

Tornado Mitigation

- Damage Mitigation
- Life Safety



Tornado Mitigation Market Analysis

- New homes constructed after May 1999, using wind resistant technology have been well received by the market.
- Home Creations reports that roughly 50% of their growth since May 1999 is due to the marketing of wind resistant features.
 - Anchor Bolts
 - Roof anchors
 - Enhanced exterior sheathing.

Tornado Mitigation Market Analysis

- Some builders in OKC and Tulsa have begun installing saferooms/multi-purpose rooms. (Greenway Group)
- Retrofit shelters as % of Building Permits

1999-2002

OKC	Moore	Midwest City	Norman
22.1%	39.9%	68.4%	10.0%

Tornado Mitigation Market Analysis

- University of Oklahoma and Austin College
 - Using 2005 MLS data and tornado shelter inventory we can estimate the effect of tornado mitigation on resale price
 - Effect of community shelters on lot rent in mobile home parks
- Austin College
 - Analysis of the household attributes which make purchase of mitigation more likely

**All projects funded by the Institute for Catastrophic
Loss Reduction – Toronto, Canada**

Do Shelters Have Market Value?



- Residential sales data on homes in Oklahoma County, OK, during 2005.
- Tax Assessor Data
- State Inventory of Shelters
- Total Observations – 13,641

Do Shelters Have Market Value?

- A shelter significantly increased the sales price by about 3 ½ percent for the average home.
- This represents a \$4200 premium for the typical home in our sample.
- This premium is within the range of estimated cost of shelter installation which varies from \$1500 on the low end to almost \$10,000 on the upper end.



The Mobile Home Problem

- Tornado shelters can be cost effective in mobile homes, in tornado prone states.
- 162,000 mobile homes in Oklahoma in 2000, about 1.97 mobile home fatalities per year.
- \$6.2 million cost per life saved.
- Cost could be lower with community shelters in mobile home parks.

Manufactured Home Parks and Shelters

- Many manufactured home parks in tornado prone states already offer tornado shelters as an amenity for park residents.
- Almost 60% of parks in Oklahoma offer shelters, lots in parks with shelters rent for 5% extra per month, everything else equal.

Tornado Mitigation Policy Analysis

- Oklahoma Saferoom Initiative.
 - Initial program was oversubscribed.
 - Local programs in Ada and Lawton.
 - Newest statewide program (2004).
 - Applications increased in counties with higher historical tornado frequency.
- SQ 696 – Tax Incentive for Saferooms.

Building Safer Mobile Homes

- In 1994, HUD enacted new wind load requirements for manufactured homes in coastal areas.
- In February 2007, two tornadoes struck Lake County, Florida, killing 21 people, all in mobile homes.
- In no case did we find that anybody died in a mobile home built after 1994.
- Homes built to the wind code were 79% less likely to be destroyed than homes built prior to 1976.

Mitigation: From the Ivory Tower to the Real World

- Does regulation work?
 - Clearly enhanced building codes provided better protection from Hurricane Charley.
 - The challenge is gaining the support of builders and the ultimate consumers of coastal properties.

Mitigation: From the Ivory Tower to the Real World

- Do markets for mitigation work?
 - Consumers must perceive a risk before behavior changes.
- Key for consumers will be consistent information from a variety of sources:
 - Government
 - Insurance Companies
 - Suppliers
 - Universities

Mitigation: From the Ivory Tower to the Real World

- Consumer interest is highest in the aftermath of an event.
- Acceptance of mitigation can be extended beyond the immediate event reaction.
 - Message about the need for mitigation must be consistent from all sources.
 - Should not be a “New” message.
 - Message should continue, even beyond the immediate period following a storm.

Mitigation: From the Ivory Tower to the Real World

- When consumers see government, industry and academia working as partners, information concerning mitigation becomes more credible.

Ending with A Pleasant Weather Phenomenon

